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NEW SERIES, VOL. XXXIV OCTOBER, 1936 No. 1

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EDITORIAL

THE PRESENT TREND IN SURGERY*

As we review the development of surgery we see that there are definite periods into which progress may be placed.

During the pre-anesthetic period the only surgery that was undertaken was urgent or emergency surgery, largely amputations and such surgery as was made necessary by trauma. The successful surgeon of that period possessed at least two prerequisites, speed and an accurate knowledge of anatomy.

With the development of modern methods we regret the passing of one of those attributes so essential to good work, that of anatomical knowledge.

Less than one hundred years ago Crawford W. Long first successfully used ether for surgical anesthesia. Morton, four years later, in 1846, first used ether in the Massachusetts General Hospital.

As the advantages of anesthesia became generally known the scope of surgical procedures increased, but it remained for Pasteur and Lister to recognize the fundamental causes of danger in technical procedures. It remained for them further to enunciate the principles on which modern surgery has been founded.

Surgery then went through the bacteriologic phase, without which the sacred precints of the abdomen, chest and cranial cavity would not have been reached.

The epoch making contributions of Pasteur and Lister were not readily accepted, in fact it required at least twenty years for the adoption of safe methods of antisepsis and asepsis.

Review of hospital records, such as they were, in the latter part of the nineteenth century reveals that relatively few elective operations were performed. Bold surgeons began to develop technical procedures in the hope that the knowledge of pathology gained at the operating table would enable

* Presented before the New Orleans Academy of Science, March, 1936.

them in time to successfully remove some of the lesions which they knew were taking such a terrible toll. The result of this may be seen in the great number of new operations which were devised or suggested for pathology within the stomach, gall bladder, intestines, thyroid and other organs. This phase of surgical development may well be considered one of technical improvement.

It was during this period that the *x*-ray was discovered by Roentgen, and its usefulness became apparent to a group of pioneers.

Technical procedures became highly standardized and the dangers incident to operation diminished almost to a vanishing point so that not only the qualified surgical anatomist was permitted to do surgery but the novice approached surgical problems with an assurance that proved to be anything but a blessing to the patient.

With the increasing usefulness of laboratory information and the availability of the *x*-ray we have to lament the failure of an oncoming generation to become good clinicians.

The development of biological chemistry served as a means of increasing our appreciation of physiologic dysfunction.

The present trend in surgery is along physiologic lines. The tendency today may be summarized by saying that there is a greater cooperation of effort and coordination of knowledge than in former periods.

Certain diseases which seemed to baffle the efforts of clinicians in the past have now been definitely placed in the category of surgically curable conditions. The most spectacular of this group may be mentioned certain diseases in which the spleen plays a part, particularly purpura, hemolytic jaundice and splenic anemia. Aschoff pointed out that the spleen, bone marrow, Kupfer cells, and hemolymph glands form the so-called reticuloendothelial system. Disturbance of the function of portions of this system produce definite syndromes. Of these syndromes that which is known as purpura hemorrhagica is cured in a spectacular fashion by splenectomy.

In the development of the present treatment of this disease the results which were to be obtained were anticipated because of information made available by research with reference to platelets and the part they play in the control of hemorrhage.

On the other hand pernicious anemia had been placed in the surgical column until the part played by liver feeding indicated that surgery should not be the procedure of choice.

In this same field guided by laboratory data a certain damping influence has been put upon the enthusiasts for gastrectomy. Castle and others have shown that a blood picture simulating pernicious anemia follows total gastrectomy not only experimentally but in clinical cases. This warning may well be heeded. The question of whether one might die more comfortably with an ulcer of the stomach or pernicious anemia had to be answered. If there is a happy medium that course should be followed. Fortunately there is a happy medium and such radical surgery is unnecessary for the cure of the major number of ulcers of the stomach.

The influence of the discoveries of Banting and Best on surgical progress is being more and more generally appreciated. The attitude toward the surgical diabetic has been entirely altered as the result of the discovery of insulin. Before insulin, surgery was almost never undertaken as an elective procedure. Today with the cooperation of the skilled internist the risk of surgery in the diabetic is only slightly greater than in the non-diabetic.

The possibilities of surgery of the pancreas have been greatly increased through the accumulation of physiologic data with reference to the function of the islands of Langerhan. It is now appreciated that hyperactivity of these islands produces a definite hypoglycemia, or as it has been labelled, hyperinsulinism. This knowledge has led clinicians and surgeons to the logical investigation of the question of the

amenability of this syndrome to surgery. At operation and at autopsy adenomata of the pancreas have been found in cases presenting the syndrome of hyperinsulinism. Removal of these tumors has resulted in cures. Further, it has been found that in cases where no tumor is present and disease of the pituitary and adrenals has been eliminated as a possible source of trouble, removal of the greater part of the body and tail of the pancreas has restored the patient to health just as thyroidectomy has done in hyperthyroidism.

The physiologic impress on surgical procedures is also noted in the development and in the management of decompensated heart disease and angina.

The surgical advances made possible by the ever increasing information with reference to the sympathetic nervous system are dazzling to the imagination.

The appreciation of energy control through activation of the sympathetic nervous system has been the means of giving through the poetic genius of Crile theories of shock, kinetic drive, and more recently his researches among wild animals has made possible the correlation of many facts concerning the interdependence of certain organs on energy production.

As a result of the present status of knowledge of the relationship of normal blood pressure to adrenals and sympathetics, surgical procedures for the management of essential hypertension have developed. Evidence of the part played by physiologic phenomena in the present surgical trends is indicated by the recent attempts to help the otherwise hopelessly ill heart cases with decompensation either by thyroid surgery or sympathetic nerve surgery.

Blumgart and Berlin, and other workers, have suggested that complete thyroidectomy be done for decompensated heart cases. In brief this is based on the idea that if the metabolism is lowered by ablation of the thyroid there will be a slowing of the heart rate, a decreased minute volume of blood and a consequent increased rest for the heart, thus offering an opportunity for increased nutrition of the heart muscle and therefore a chance for improvement. In some cases this has proved of value.

Thyroid ablation has also been advocated by some for angina on the basis of work reduction. It has been shown that even after thyroid ablation injection of adrenalin may produce evidence of painful anginal seizures. Some experimental investigators have maintained that relief comes through "decreased sensitivity of the heart to adrenalin effect."

Sympathetic stimulation increases adrenal output. Anything which will diminish or remove this stimulation from the heart should be effective in relieving anginal pain. Physiologic investigations have thus paved the way for operations upon sympathetics for the relief of this distressing condition.

Parathyroid surgery has been stimulated by increased information with reference to the regulatory action by these glands on calcium and phosphorus metabolism. It is only within recent years that the surgical significance of this regulatory function has been appreciated. The manifestations of hyperparathyroidism is recognizable by biochemical data and *x*-ray evidence, particularly osteoporosis. Removal of "adenomas" of the parathyroid has resulted in a reversal of the process with a resultant recalcification of the osteoporotic areas.

Churchill in 1934, stated that the diagnosis of hyperparathyroidism is one of the most spectacular and notable achievements of the laboratory of experimental medicine.

The present day trend in the management of postoperative complications indicates the appreciation of accumulated physiologic data, particularly along the lines of the maintenance of fluid balance and the need of the body for certain electrolytes. The postoperative course of the surgical patient has been made less stormy by the application of physiologic principles. The laboratory has further provided evidence which enables us to differentiate between and to apply methods

for the relief and prevention of acidosis and alkalosis.

Functional kidney tests and biochemical tests provide essential data with reference to the reserve of the patient. By utilizing such data one can readily note the difference in hospital morbidity of yesterday and today.

Vascular disease problems have been attacked within recent years along physiologic lines with at least a hope of finding relief of pain if not cure of otherwise hopeless types of cases.

Thoracic surgery, particularly the grave problem of the management of tuberculosis, has found an outlet by the application of the principles of physiologic rest for the diseased lung. Phrenic nerve surgery, pneumothorax and extra-pleural thoracoplasty owe their utilization to the appreciation of the value of physiologic rest.

In closing let me point out that it is true that experimental physiologic data that produces an unwarranted enthusiasm may cause the pendulum to swing too far, yet one cannot deny the fact that the present trend in surgery is along lines indicated to overcome those factors which are causing a perversion of the normal function.

Prophetic statements are always frought with danger, however one may venture the hope that advances will continue along the lines indicated by increasing physiologic functional data.

It must not be overlooked, however, that the surgeon of today should be thoroughly armed with a knowledge of anatomy that he might attack the newer problems directly and with as little insult to tissue as possible. He should be informed about all technical advances, but he should not hasten to sponsor those procedures not seasoned by sufficient experimental or clinical data. Spectacular procedures are often of passing value.

The surgeon of today, as of yesterday, should above all be honest and conscientious in his advice with reference to procedures to be adopted.

The surgeon must not forget that the primary indication for surgery is that the technical procedure advocated should be less dangerous than the disease from which the patient is suffering.

The widening field of surgery requires that its followers should be qualified to deal with human life placed in their hands with due reverence for the undertaking before them.

Isidore Cohn.

CORRECTION

Dr. Daniel Klein, not Dr. Samuel Klein, is the co-author with Dr. Walter A. Coakley of the article, Progressive Gangrene of the Skin, which appeared in the August, 1936, issue.

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MORPHINE AS AN AID IN DIAGNOSING ACUTE ABDOMINAL AFFECTIONS*

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CHICAGO

IT is generally believed that the use of morphine in a patient with an undiagnosed acute abdominal affection is dangerous and that the administration of the alkaloid should be strictly interdicted until the diagnosis is established. Evidence in support of this statement can be obtained by reference to almost every surgical work dealing with the subject of acute abdominal disease. It is unnecessary to quote from many separate sources for it probably suffices to repeat Cope's[1] eloquent admonition which can be considered representative of the universal opinion on the subject. In his book entitled "The Early Diagnosis of the Acute Abdomen," Cope writes with reference to the exhibition of morphine prior to the establishment of the diagnosis,

> The patient cries out for relief, the relatives are insistent that something shall be done, and the humane disciple of Aesculapius may think it is his first duty to diminish or banish the too obvious agony by administering a narcotic. Such a policy is often a fatal mistake. Though it may appear cruel, it is really kind to withhold morphine until one is certain or not that surgical interference is necessary, i.e. until a reasonable diagnosis has been made. Morphine does little or nothing to stop serious intra-abdominal disease, but it puts an efficient screen in front of the symptoms. The fire burns, but it is not visible and sometimes only when the vitality is burnt out is the mistake realized. If morphine be administered, it is possible for a patient to die happy in the belief that he is on the road to recovery, and in some cases the medical attendant may for a time be induced to share the delusive hope.

If prejudice is cast aside and the pertinent facts alone are carefully considered, the conclusion is soon reached that in the hands of an intelligent physician, morphine is not at all dangerous. It is true that morphine modifies or relieves the patient's pain, however, the behaviour of pain of itself although often important is not necessarily an index to the course of the disease or of aid in the diagnosis. On the one hand abdominal pain may persist or increase in severity and yet not require immediate or ultimate laparotomy, as for instance in renal or biliary colic, gastric crises of tabes, lead colic, etc. In fact, operation may be contraindicated, as in thoracic disease with referred abdominal pain, viz., coronary thrombosis, lobar pneumonia, etc. On the other hand, the pain may decrease in severity or subside and yet the disease process advance. For instance, the pain of appendicitis often, but not usually, disappears with the onset of gangrene and the violent colicky pains of intestinal obstruction cease with supervention of complete obstruction of the lumen or of the blood supply. Furthermore, there are several symptoms and signs other than pain which are not masked by the administration of morphine and which continue to guide in arriving at a correct diagnosis. The general appearance, the temperature, pulse and respiratory rates, the tenderness, the resistance, distention, peristaltic activity, character of the gastroduodenal content, results of enemas, blood counts and roentgenologic signs are all extremely important in the diagnostic consideration and are not modified by the administration of morphine. The statement made by Guerry,[2] viz., "Morphine puts two people to sleep, the patient on the one hand and the doctor on the other," need not be true unless the

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† Died August 21, 1936.

degree of subjective pain serves as the sole guide to the diagnosis and all physical and laboratory signs are disregarded by the examining physician.

If the preconceived idea that morphine is dangerous in acute abdominal diagnosis is abandoned, it is soon found that in selected cases the drug is distinctly helpful. During the past five years the author has employed morphine or its derivatives in several hundred patients with an "acute surgical abdomen" and has observed that the drug is of inestimable value in certain cases and at times even indispensable. In some instances, where he and others failed to establish the correct diagnosis, the underlying disease was subsequently rendered apparent by the effects of a hypodermic of morphine. By demonstrating the action of morphine on patients with acute abdominal disease the author has succeeded in convincing even those previously opposed to its use, of the value of the drug as a diagnostic aid. Other writers have commented on the beneficial effects of morphine in the diagnostic period of acute abdominal disease but the total number constitutes only a handful. Besides, each author makes either casual mention of the value of morphine or finds it helpful only in one or two connections. No one, so far as can be ascertained, has done justice to the subject and indicated the various conditions under which the alkaloid can be of aid to the clinician in the diagnosis of the "acute abdomen."

One of the most important aids and at times actually the only means through which a correct diagnosis of an acute abdomen is made is the patient's history. There are so many different abdominal affections in which at the time the patient is first seen the physical signs are almost identical, that a careful account of the development of the illness is frequently indispensable. Where the pain is only moderate, morphine is not required. However, if the pain is relatively severe, the patient is disinclined to concentrate on the history and will omit details or be indifferent to the examiner's questions. The result will be an inaccurate or a misleading history. If the pain is extremely violent, the patient is unable to give more than a fragmentary account and limits his answers as much as possible to monosyllables. The administration of a narcotic in abolishing or moderating pain permits the patient to think and talk freely and to furnish the examiner with a reliable history. The author has had occasion to demonstrate repeatedly the necessity of a "minute-by-minute" description of the onset in order to differentiate perforated peptic ulcer for instance from acute gall-bladder disease, appendicitis, etc. This type of history almost requires freedom from severe pain. The technique of the "minute-by-minute" history and its significance has been described elsewhere.[3] Where acute manifestations are in some manner linked to a chronic abdominal lesion, as acute peritonitis consecutive to a carcinoma of the colon or acute pancreatitis secondary to an old standing gall-bladder disease, the antecedent history is often essential if a correct preoperative diagnosis is to be made. The author has several times succeeded in arriving at a correct diagnosis in such cases through the aid of morphine when previous attempts prior to the relief of pain failed. No mention was found in the literature of the value of morphine in connection with history taking but the author has employed the narcotic at times for this purpose alone with gratifying results. It is remarkable to observe how quickly and completely the confidence of the patient is won by the physician who is responsible for the relief.

Morphine is of value in the diagnosis of acute abdominal disease not only because of its aid in connection with the history but also on account of its help in the physical examination. The literature on the subject deals practically exclusively with this latter phase of the narcotic in abdominal diagnosis. Libman,[4] in treating of desensitization of pain writes, "In cases in which there is so much local muscular

spasm and tenderness that one is in doubt whether a chest condition, such as pneumonia, or an acute abdominal disease is present, a hypodermic injection of morphine may diminish the muscular spasm and tenderness sufficiently to permit of a more conclusive examination." Hildebrandt[5] recommends morphine as an aid in the localization of the original focus in cases with diffuse tenderness. This author points out that in the presence of diffuse peritonitis, following morphine he finds almost with certainty, one place which is particularly tender. Here the original focus is found. The latest and by far the most elaborate and painstaking study of the relationship of morphine to acute abdominal diagnosis is that of Zierold.[6] This author offers data purporting to show that abdominal muscle spasm as it presents itself clinically has two components; (1) a local spinal reflex due to local stimulation by the inflamed organ and occurs when the stimulus is minimal and (2) a widespread response due to cortical stimulation and occurs when the sensory stimulus is excessive and overleaps the bounds of the local spinal reflex. Zierold maintains that by the administration of morphine in sufficient amount to abolish pain, the extraneous cortical component of the muscular spasm is removed leaving simply that element of rigidity affected solely by the spinal reflex.

It is not the purpose of this paper to discuss the nervous mechanism by which morphine produces its effects but rather to indicate the wide field of usefulness of the drug in acute abdominal diagnosis. From a perusal of the literature which is summarized one gains the impression that morphine can be employed to advantage in only very few abdominal conditions. As a matter of fact, morphine is of value in many different types of acute abdominal disease, as will be shown later. Experience has demonstrated that the more one resorts to the alkaloid in diagnosis the more indications does one find for its use. The author ascribes the help which morphine affords the clinician to the production of abdominal relaxation and the reduction or elimination of the hyperesthesia. With the abdomen relaxed and the hyperesthesia more or less eliminated the examiner can determine with a fair degree of accuracy (1) the location of the point of maximum tenderness, (2) the degree of tenderness and (3) the presence or absence of an abdominal mass. This is true when the resistance happens to be either bilateral or diffuse, or unilateral or localized. When an abdomen is diffusely rigid, and quite hyperesthetic, the physical examination generally yields but little information of diagnostic worth. In order to palpate the contents of the peritoneal cavity so much force is required to penetrate the resistance of the abdominal wall that the location of the maximum point of tenderness or the degree of tenderness cannot be ascertained. After morphine is administered the hyperesthesia is removed and abdominal relaxation is secured. Then one has little difficulty in cases of diffuse peritonitis, as observed by Hildebrandt, in localizing the point of maximum tenderness which generally proves to be the source of the inflammation. The differentiation of perforated peptic ulcer from a ruptured appendix, a ruptured ovarian cyst, a strangulated bowel with peritonitis, etc., is frequently required in general practice and is aided materially by a knowledge of the site of maximum tenderness. When the abdomen is diffusely rigid due to extra-abdominal disease, as either thoracic or spinal, the degree of tenderness is only slight, certainly insufficient to account for the intense muscular contraction. However, as stated in the foregoing, due to the force required to overcome the *defense musculaire* one cannot determine how much tenderness accompanies the rigidity. If however, the patient receives a narcotic, the abdominal wall relaxes and the absence of marked tenderness is satisfactorily demonstrated. It might be well to emphasize at this point that morphine in the amount required to relieve subjective pain may modify somewhat but does not

abolish tenderness due to chemical or bacterial inflammation. Thus it is seen that morphine aids in the distinction between intra- and extra-abdominal disease since in the former instance exquisite tenderness is elicited in spite of the narcotic.

It can be stated without fear of contradiction that detection of a small or moderate sized mass in the presence of diffuse rigidity accompanied by hyperesthesia is a rarity. Generally, in the presence of a resistant abdominal wall the examiner does not even endeavor to palpate for a circumscribed swelling. However, if an injection of morphine or its equivalent is given, a mass, if present, can be readily identified, being located as a rule at the site of maximum tenderness. The preoperative knowledge of its presence may have a distinct bearing on whether a surgical or medical procedure should be followed, and (2) if surgical, the location and type of incision to be made. Employing morphine as a diagnostic aid the writer has been enabled to identify masses of an inflammatory character, in connection with appendicitis, diverticulitis of the sigmoid and carcinoma of the small bowel, where rupture of an abscess had led to the picture of diffuse peritonitis accompanied by a pneumoperitoneum. Prior to the time that these patients received morphine, the diagnosis of a perforated peptic ulcer was made based particularly on the presence of free air seen fluoroscopically. The demonstration of a mass in locations other than the stomach and duodenum led to the correct diagnosis of the source of the peritonitis in each instance.

When the resistance to palpation is local or unilateral, morphine does not serve as useful a purpose as when the entire abdomen is rigid. Nevertheless, the occasion not infrequently arises where only through the employment of morphine the point of maximum tenderness, the degree of tenderness and the presence of a mass can be determined. One of the common errors in abdominal diagnosis is to confound acute appendicitis and acute gall-bladder disease. The tenderness in both affections may involve more or less the entire right side and the decision is generally based on the habitus of the patient. Recently a slender male developed right sided abdominal pain with tenderness elicited in both the upper and lower quadrants on the side of the pain. Acute appendicitis was assumed and operation recommended by the attending surgeon. After the routine preoperative dose of morphine was administered the writer had the opportunity of examining the patient and was able to demonstrate that the maximum point of tenderness was located beneath the right costal arch. Notwithstanding, a laparotomy disclosed an inflamed gall bladder containing several stones and a normal appendix. The preoperative determination of the point of maximum tenderness is of value also in selecting the type and site of incision to be used for acute appendicitis. When the appendix lies in an atypical location i.e., subhepatic, pelvic, retrocecal and lateral, etc., the usual McBurney incision will require secondary extension, or a separate incision, or will force the surgeon to work under a handicap with resultant prolongation of the operative time and increased trauma to the tissues. My colleague, Dr. Peter A. Rosi has been able to confirm the observation that the inflamed appendix lies beneath the point of maximum tenderness and chooses his incision accordingly.

The value of morphine in determining the degree of tenderness when the resistance to palpation is local, is illustrated in the following case.

A slightly obese woman of thirty-two years of age, suffered acute pain referred to the right lower quadrant of the abdomen. There was local resistance to pressure and marked tenderness. The patient stated that she had been operated previously for an appendiceal abscess at which time her appendix had been removed. She herself saw the appendix after the operation. The patient's husband confirmed the story and stated that he also had seen the amputated appendix. With the history of a previous appendectomy, it was then

assumed that the physical signs were due to a low grade typhilitis. Morphine, gr. ¼, was administered following which the pain subsided and the resistance receded. The tenderness, however, was just as marked as before the injection of the alkaloid. Due to the persistence of decided tenderness, in spite of the disappearance of spontaneous pain a suppurative lesion of the right lower quadrant was diagnosed and operation advised. At laparotomy an acute suppurative appendicitis was found. Evidently, the appendix had not been removed at the time of the first operation.

As stated in connection with the discussion on diffuse rigidity, a patient who is in pain is likely to react to pressure out of proportion to the amount of inflammation present, due to the accompanying hyperesthesia. With relief of the spontaneous pain the hyperesthesia is more or less removed permitting the examiner to determine the true degree of tenderness which is proportionate, other things being equal, to the severity of the inflammation present.

With regard to the demonstration of a mass in the presence of unilateral rigidity one can apply what already has been said in the discussion on palpable masses where diffuse rigidity exists. It should be constantly borne in mind that when bilateral and simultaneous palpation is made and so-called muscle spasm is found confined to one area of the abdomen, an underlying mass is generally the explanation of the increased resistance on one side. In this connection it may be pertinent to point out that there is a growing tendency to treat neglected appendicitis conservatively, rather than to operate whenever the diagnosis is made. Operation in the presence of a periappendiceal mass shortly after the third day is considered inadvisable because of the fact that the inflammatory process is localizing and manipulation will tend to spread the infection. One surgeon of wide experience has advised that if after opening the abdomen a localized periappendiceal mass is encountered, the abdomen should be closed promptly and the patient be treated according to the Ochsner method. Another surgeon advised that after the patient is anesthetized that the right lower quadrant be palpated for the presence of a mass and if one is found, that the anesthesia be stopped and the operation withheld. It is the writer's opinion and experience that in most instances, careful examination after morphine administration will permit identification of a mass which cannot be discerned prior to the injection of the alkaloid. With morphine available, resort to anesthesia or to operation should seldom be necessary in order to establish the presence of a mass.

The method of procedure which the author employs is as follows: If the patient when first seen is not in great agony and is able to give an adequate account of his illness no morphine is administered during the diagnostic period. If, however, the patient is found to be quite ill and has to put forth great effort in order to answer questions only a sketchy history is obtained. The brief anamnesis is usually sufficient to guide one in the preliminary physical examination which is made now and includes only the essentials. The physical observations are then noted in writing. After the preliminary examination, the patient is given a hypodermic of morphine sulphate, gr. ¼, or its derivative, dilaudid, gr. 1/20, generally *intravenously*. Dilaudid is preferred where narcosis is undesirable. Within a minute or so the patient is relieved of the pain or at least the pain is rendered tolerable. Exceptionally, the dose has to be repeated. A more detailed history is then obtained and is followed by a complete and painstaking physical and when indicated, fluoroscopic examination. The mentioned technique, by permitting the clinician to examine the patient before and after morphine, renders available, all the clinical signs and symptoms without making it necessary to establish "the diagnosis at the expense of exhausting pain" (Cushing quoted by Fantus[7]). After one has utilized this procedure a number of times, he learns how much allowance to make for the morphine in evaluating the degree

of pain, tenderness, etc. Surgeons seldom reexamine their patients after the preoperative dose of morphine is administered. If they were to do so, they would be in a position to judge the effect of the narcotic and realize the advantages of employing the drug.

The intravenous route is chosen because of the promptness of action and the effectiveness of the narcotic. The relief experienced by the patient is almost instantaneous and the relaxation of the abdominal wall is more or less complete. Where the subcutaneous injection is used the narcotic is frequently dissipated in its effect and adequate relief and relaxation do not follow. No harmful results have been observed by the author in several hundred cases in which the intravenous administration has been used. It is to be remembered that only those patients suffering severe pain received morphine directly into the vein. Hildebrandt[5] states that he has employed morphine intravenously for years not only for "quick relief but also as a diagnostic aid." He apparently has had no ill effects. Jacobaeus[8] recommends intravenous administration of morphine for the control of pain in inoperable carcinoma. He also, presumably, has had no untoward symptoms from its use by this method. On the other hand Lambert[9] in writing on morphinism states that the accidental intravenous injection of morphine has caused sudden death. His material however consists chiefly of addicts who apparently were not suffering intense physical pain when the injection was made and who may have taken extremely large doses.

Before concluding the discussion of the value of morphine in the diagnosis of the acute abdomen it might be well to stress that the administration of the drug is of distinct benefit therapeutically. It is generally recognized that continued, severe pain exhausts a patient and thereby increases the operative risk. The employment of a narcotic early in the diagnostic period makes the patient better able to withstand the operation and to resist possible complications. It is also agreed that morphine constitutes one of the most effective therapeutic weapons in combating "shock" and hemorrhage. Cutler and Holloway[10] in an article dealing with the indispensable uses of narcotics in surgery, write "To those who went through the war as surgeons, particularly to those who worked nearest the 'line,' it almost seemed that military surgery would have been impossible without morphine." In cases of internal injuries in civil life, Mannheim[11] recommends the immediate administration of a large dose of morphine, which he states is a life-saving measure.

There are, as might be anticipated, certain disadvantages in the use of morphine as a diagnostic adjunct. They are, however, not of sufficient importance to outweigh the advantages. One drawback to morphine is that it deceives those patients who do not appreciate the fact that relief from pain is not synonymous with general improvement. Very few individuals with pain of sufficient intensity to require morphine for diagnostic purposes refuse to submit to surgery while in their agony. In fact, many plead frantically for immediate operative intervention. When the pain is relieved, however, by the administration of the narcotic some patients decline or delay laparotomy. For this reason care should be taken to apprize the patient of the selective effect of morphine on the pain and of its failure to influence the course of the disease. Another objection which might be raised against the use of morphine in the prediagnostic period is in cases of intestinal obstruction. One of the helpful signs in the diagnosis of mechanical obstruction is the extremely active peristalsis heard synchronously with the height of the paroxysm of pain. When morphine is administered the colicky pain frequently abates and the gurgling auscultatory signs disappear. If the attending physician follows the practice suggested in a preceding paragraph of making a preliminary examination before administering the narcotic, he will avoid being deprived of any useful data. It might be pertinent to add that the author has

found that in certain cases of obstruction, particularly neglected ones, morphine has been of distinct value in the conservative management along with Wangensteen's[12] method of decompression.

CONCLUSIONS

It is universally taught that morphine should not be administered to a patient with an acute abdominal affection until the diagnosis has been established or at least until a decision as to whether or not to operate has been reached. The objection to the drug during the diagnostic period is that the narcotic "masks" the clinical picture. As a matter of fact the only sign, symptom or laboratory test which is affected by the morphine is the pain and its related manifestations, principally rigidity and hyperesthesia. Only when pain is the physician's sole guide to the diagnosis is morphine dangerous and when this is the case the physician himself is dangerous even without morphine.

By virtue of the fact that the alkaloid relieves or moderates pain and removes thereby, in part at least, the abdominal wall resistance and the hyperesthesia, morphine is often most helpful in the diagnosis of acute abdominal affections. When the suffering of the patient is great, a trustworthy and adequate history cannot be obtained without first employing a narcotic to assuage the agony. When the physical signs are difficult to elicit or are equivocal the administration of morphine permits a much more satisfactory examination.

The procedure of the author is as follows: The ordinary case is handled in the customary manner. If, however, the patient is unable to cooperate in the taking of the history or in the physical examination on account of the severity of the pain, a sketchy anamnesis is obtained and a preliminary examination made and the observations recorded. Morphine sulphate, gr. ¼, or its equivalent, dilaudid gr. 1/20, is injected *intravenously*. The effect is very prompt and striking. An adequate history is now obtained and a complete, careful physical examination can be done. Observations made before and after morphine can then be compared.

In addition to aiding the examiner in arriving at a correct interpretation of symptoms, morphine administered early in the diagnostic period spares the patient unnecessary suffering and renders him a better operative risk. Morphine is conceded to be one of the most effective therapeutic agents in counteracting the effects of "shock," hemorrhage and also peritonitis. From what has been said it is quite clear that we have deprived ourselves and our patients with acute abdominal affections of the benefits of morphine and in the words of Moynihan,[13] "Many of us have become frightened of the drug, quite needlessly, for properly used its value is beyond question."

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DISEASES OF THE THYROID GLAND*

A CORRELATION OF CLINICAL AND PATHOLOGICAL MATERIAL

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THE increase in recent years in the number of patients operated upon for goitre, has enlarged our knowledge of the clinical manifestations of thyroid disease and has made available for study a large amount of pathological material. Separately and on the basis of their peculiar experience and observations, the clinicians and pathologists have devised classifications of thyroid disease. These different types of classification confuse the student encountering the problem of goitre.

The Committee on Nomenclature and Classification of Disease,[1] in 1931 grouped all diseases of the thyroid exclusive of malignant lesions, inflammation and the rarer types of disturbances, under four headings: non-toxic diffuse goitre, toxic diffuse goitre, toxic nodular goitre and non-toxic nodular goitre. In reviewing the clinical findings in over 300 cases of thyroid disease and studying the glands removed at operation from the same cases, it was apparent that a definite relationship existed between the clinical picture and the pathological changes in the thyroid gland. Some of the facts determined by this study are embraced in the following pages for the purpose of grouping clinical and pathological data under the mentioned headings and presenting a simple, concise conception of thyroid disease.

NON-TOXIC DIFFUSE GOITRE

The enlargement of the thyroid gland commonly referred to as "simple"[2] or "endemic"[3] goitre, occurs during adolescence and early adult life. It is more common in women than in men in a ratio of 6 to 1. So insidious is the onset of the disease that the patient rarely is able to recall the exact time when the goitre first appeared. Disfigurement of the neck by the mass is the most common complaint. There may be symptoms of pressure upon other cervical structures by the enlarged gland; these in order of frequency are cough, tendency to repeated swallowing, hoarseness, stridor and pain.

The gland may be diffusely enlarged or one lobe or the isthmus alone may be affected. The degree of enlargement varies but when signs of pressure exist, the gland is usually many times its normal size. Compression of the veins of the neck may be produced by the glandular enlargement.

Gross Examination. The thyroid in non-toxic diffuse goitre appears lighter in color than the normal gland. Sometimes it presents a mottled aspect due to interference with the circulation through its vessels. The consistency of the gland is uniformly soft. On section it is moist and light amber in color. When a knife blade is drawn across its cut surface, a honeycomb appearance is revealed and when pressure is applied to it, the surface exudes a thin, watery, light yellow substance.

Microscopic Examination. Sections of the thyroid show the acini varying in size but usually large and distended with a uniformly staining colloid. The walls are thin and lined with low cuboidal or flattened epithelium. The cytoplasm of the cells stains deeply; the nuclei are small, round and centrally located. There are areas in which the acinal walls show several layers of cells; these abutments are known as "Sanderson's polsters."[4] In some acini thin, withered spurs of epithelial cells may be seen projecting into the lumen. Because of the cellular proliferation and the enlargement of the acini, the connective structures appear inconspicuous

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and avascular. There are, however, areas of lymphoid hyperplasia around the vessels in the interacinal spaces. (Fig. 1.)

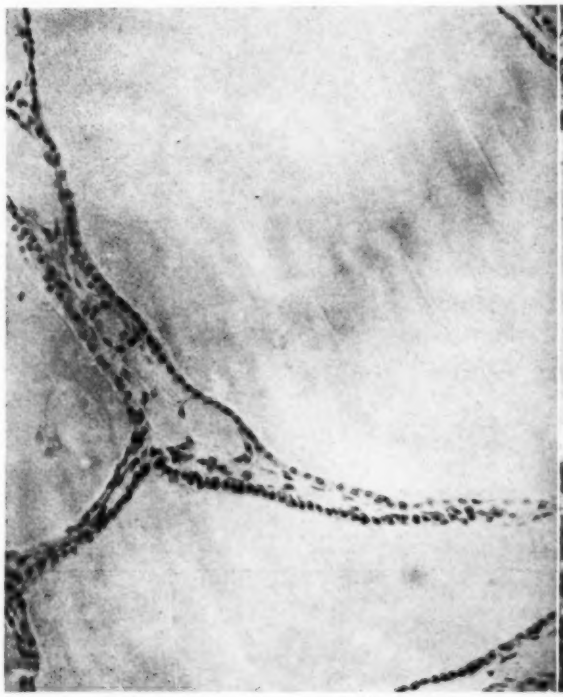

Fig. 1. The acini are large and distended with a uniformly staining colloid. The cells lining the acini are of low cuboidal or flattened epithelium. The nuclei are uniform in size and staining properties, and are located in the center of the cell.

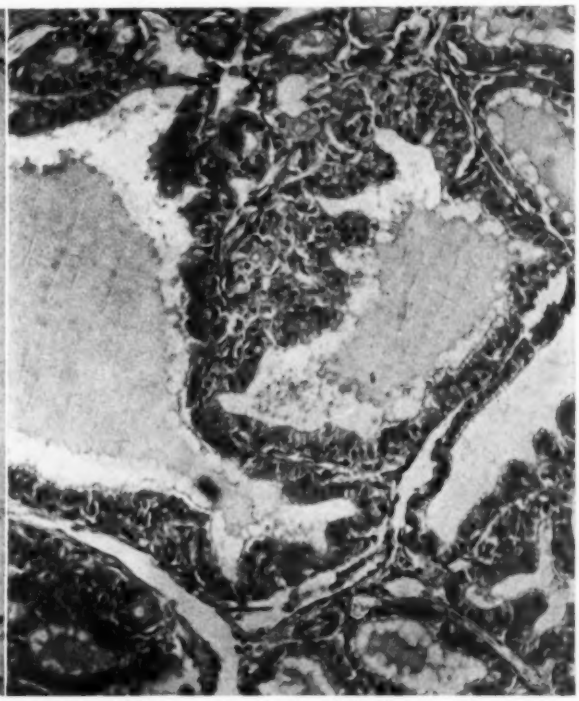

Fig. 2. There is marked epithelial overgrowth, the cells lining the acini have proliferated and become heaped up so as to encroach upon the lumen by papillary projections. The acini contain scant colloid, with large vacuolated areas at their periphery. The individual cells are large and usually high cuboidal or even columnar. The nuclei are irregular in size and location.

TOXIC DIFFUSE GOITRE

Toxic diffuse goitre is a disease characterized by diffuse enlargement of the thyroid associated with hyperfunction which stimulates abnormal activity of the vegetative nervous system; the manifestations of the disease are nervousness, increased metabolic rates, increased pulse rates and, in many cases, exophthalmos. This condition is referred to in the literature variously as "exophthalmic goitre,"[5] "Graves' disease,"[6] "Basedow's disease"[7] and "hyperthyroidism."

Toxic goitre has its onset more commonly in the second or third decades of life, though it has been observed from infancy to old age. It affects women more often than men, the ratio being 9 to 1. In the majority of cases the onset of symptoms may be traced to a period of emotional strain or psychic shock. The course of the disease may be rapidly progressive or it may be interrupted by periods of regression of symptoms. In either case, the administration of iodine may result in rapid disappearance of the signs of hyperthyroidism. The improvement in the clinical picture is accompanied by changes in the thyroid gland which appear both on gross and microscopic examination.

Gross Examination. In toxic diffuse goitre the thyroid usually is symmetrically enlarged; rarely the enlargement is confined to one portion of the gland, but without exception there is a demonstrable increase in its total size. In comparison with the normal thyroid it is dark in color and its vascularity is increased. The cut surface is bluish red and resembles transected striated muscle and when a knife blade is drawn across it, a brown viscid

material is expressed, leaving a granular surface. The appearance of the gland is altered after adequate iodine therapy; the connective tissue is inconspicuous because of the epithelial proliferation; the interacinal structures show increased vas-

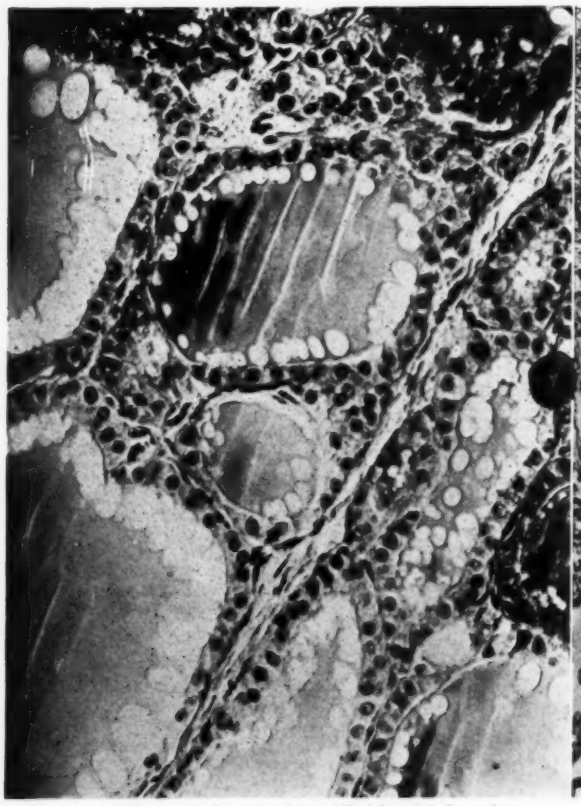

Fig. 3. The acini contain colloid which takes a deeper stain; there are areas of vacuolization. The papillary spurs of epithelium have receded. The cells are smaller, having returned to a low cuboidal type. The nuclei are more regular in size and are centrally located. The interacinal stroma is more prominent.

Fig. 4. There is no definite arrangement of the acini which are small and contain very little or no colloid. The lining cells are pale and contain small acini. The interacinal tissues are of a pale structureless material. In the center of the section may be seen a small cyst lined by flattened epithelium. Scattered through the interacinal structures are many individual epithelial cells.

then it becomes lighter in color, firmer in consistency and it exudes a translucent gelatinous material. This change is due to the larger amounts of colloid in the acini after the administration of iodine.

Microscopic Examination. The acini are irregular and their lumen, normally filled with colloid, is encroached upon by the lining cells which are increased in number and size. In some of the acini the epithelial overgrowth results in such heaping up of cells as to form papillary projections into the lumen. (Fig. 2.) In spite of the diminished space in the acini, the lumen is only partly filled with colloid of a poorly staining quality surrounded by vacuolated areas. In comparison with the normal thyroid,

cularity with scattered areas of lymphoid hyperplasia. The most significant change in the individual cell is its metamorphosis from the low cuboidal to a high columnar type. Under a high power lens the cells are seen to have lost their characteristic structure; they vary in size, shape and staining qualities. The nuclei also are irregular in structure and are not placed in the center of the cell; mitosis may occasionally be observed.

Following the administration of iodine, certain definite changes may be observed under the microscope. The acini are filled with uniformly staining colloid surrounded

by a small zone of vacuolization. The acinal lumen appears larger than previously. The cellular spurs have receded and diminished in size. The connective tissue is prominent and retains its lymphoid hyperplasia. The individual cell is smaller and displays greater uniformity in staining properties. The nuclei tend to occupy the center of the cell (Fig. 3).

The changes in the thyroid produced by the spontaneous regression of the disease or by the administration of iodine are referred to as involution. This process of transition from hyperfunction to normal physiological activity may be complete, or it may be confined to one part of the gland when it is known as incomplete involution. Uniform return to normal function of the entire gland is rarely seen and commonly all grades of transition may be observed in one specimen. Involution is accompanied by scarring of the connective tissue with persisting hyperplasia of the lymphoid elements.

TOXIC NODULAR GOITRE

Nodular goitre with hyperthyroidism occurs more commonly in the fourth and fifth decades of life and more frequently in women than men, the ratio being 5 to 1. The manifestations of hyperthyroidism are not so severe as in toxic diffuse goitre. The onset of symptoms is more insidious and the disease, therefore, less acute but of longer duration. Because of the prolonged strain upon the system in toxic nodular goitre, the disease may be associated with general organic disturbances; cardiac damage, for instance, is a frequent accompaniment of this type of goitre. In response to iodine therapy, the changes are less dramatic than in toxic diffuse goitre and the results of thyroidectomy not so pronounced.

Gross Examination. In toxic nodular goitre the gland is irregularly enlarged by the presence within its substance of one or more nodules. These nodules vary in size, distribution and structure and a single gland may contain any one or several different types. According to their structure the nodules may be classified as follows:

1. Nodules composed of normal thyroid (pseudonodules);
2. Nodules composed of hyperplastic thyroid tissue;
3. Nodules composed of colloid thyroid;
4. "Fetal adenomas" of the thyroid;
5. Cysts of the thyroid;
6. True adenomas of the thyroid.

A description of the six types of nodules is given to clarify the complex picture presented by nodular goitre.

1. The nodule composed of normal thyroid may well be defined as a pseudonodule for it assumes the shape of a nodule only because of compression and distortion by the surrounding structures. Under the microscope the tissue shows no variation from normal thyroid tissue.

2. The toxic nodule varies in size and consistency. The tissue of which it is composed is indistinguishable grossly or microscopically from the gland in toxic diffuse goitre and, like it, it undergoes the changes of involution after iodine therapy. The process of involution may be complete in one nodule and non-existant in neighboring nodules in the same goitre; even in the individual nodule there may be lack of uniformity in this respect. When complete involution has occurred, the nodule assumes the appearance of involuted tissue in toxic diffuse goitre.

3. The nodules composed of "colloid" tissue are lighter in color than either normal thyroid or the hyperplastic gland. They are usually small. Under the microscope a section is identical with one from a non-toxic diffuse goitre.

4. The so-called "fetal adenoma"[8] of the thyroid forms another type of nodule. On gross section a glazed, grey substance is seen; it is well encapsulated and flecked with areas of necrosis. Small cysts containing a colloid-like material or degenerated blood and cholesterol crystals may be found. Calcification may also be present. On microscopic examination of the smaller

nodules of adenomatous structure, the section shows a marked absence of the normal arrangement of the acini into lobules. The acini are small and widely separated by a peculiar structureless material resembling colloid. (Fig. 4.) Scattered through this substance there may be found clumps of red blood cells and many epithelial cells, either separated or arranged in groups. Small cysts filled with blood and groups of cells containing lipoid elements may also be present. The larger nodules of adenomatous tissue have a different appearance. In them there is greater evidence of degeneration; the cysts are larger and cells with lipoid content are more numerous. Areas of hyaline degeneration and calcification may be encountered. The dense fibrous capsule around the nodule often contains calcium deposition.

5. Cysts of the thyroid forming a distinct nodule of themselves or located within colloid or adenomatous nodules, vary greatly in size. They may be thin walled and filled with colloid-like material or with a chocolate colored substance flecked with crystals of cholesterol. The walls may be thick with gritty, calcified areas and solid cartilagenous projections may extend into the cavity of the cyst. Under the microscope it is possible to follow the successive stages of cyst formation and development. The rupture of several adjacent acini distended with colloid, forms a small cyst. Subsequently, neighboring acini rupture into the cyst and increase its size. The process continues in this manner until an acinal blood vessel is injured; the resulting hemorrhage mixes blood with the content of the cyst to which phagocytes containing lipoid are later added. The consequent inflammatory reaction leads to fibrous thickening of the wall with hyaline degeneration and calcium deposition.

6. True adenomas[9] of the thyroid. There is a small group of cases in which the nodule has the features of a true tumor. In such nodules the tissue is composed of strands of epithelial cells separated by a delicate stroma containing many large vessels. Under higher magnification the strands are seen to be composed of solid clusters of cells in which no lumen can be detected.

These types of tissue are not always restricted to the nodules; often any one of them may form a portion of the tissue lying between the nodules.

NON-TOXIC NODULAR GOITRE

The nodular goitre without hyperthyroidism is seen in earlier life than the toxic nodular goitre; however, it may occur in the extremes of age as well. It is encountered in women more often than in men, the ratio being 5 to 1. The goitre may be present for a long time before symptoms relating to it force the patient to consult a physician. The symptoms depend upon the degree of pressure the gland exerts upon neighboring cervical structures. Occasionally a patient will complain of manifestations commonly associated with hyperthyroidism. On close questioning it will be found that these complaints were imposed upon the imaginative patient by statements made by relatives or friends familiar with the story of hyperthyroidism. True signs of toxicity are absent.

Gross Examination. In gross appearance, this goitre is indistinguishable from toxic nodular goitre.

Microscopic Examination. The outstanding difference between this and toxic nodular goitre is the absence of nodules of hyperplastic tissue. The areas of involution and of all stages of cyst formation and degenerative changes are similar to those described under toxic nodular thyroid.

In the previous description of nodules the false adenomas have been considered. Their formation is the result of two factors, first, the physiological changes following hyperplasia and second, mechanical damage to the circulation. This view is upheld by Marine[10] in his recent work and the mechanical factor has been emphasized and described by Wangensteen[11] in his

monograph on the circulation of the thyroid. Observations of nodular goitre have been, for the most part, limited to man. Marine shows the impossibility of testing experimentally in animals any hypothesis concerning the origin of these nodules. In brief he has held that the prevention of thyroid hyperplasia completely prevents the development of the pseudofetal adenomas.

SUMMARY

A correlation between the clinical course of thyroid disease and the pathological material removed at operation in a series of cases has been presented. This is based upon a classification of thyroid disease, exclusive of malignant lesions, inflammation and the rarer disturbances, which divides goitres into four groups: non-toxic diffuse, toxic diffuse, toxic nodular and non-toxic nodular. The classification of nodular goitre is simplified by emphasizing the nature of the individual nodule.

A differentiation is made between true adenomas and the so-called "fetal adenomas."

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LUXATIO TESTIS TRAUMATICA*

AND EXPERIMENTAL STUDY OF THE MECHANISM

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TRAUMATIC dislocation of the normally descended testis is an exceedingly rare occurrence. Recently a case of this kind observed was considered of sufficient importance to report. In addition, we have collected all similar cases from the literature and have attempted an explanation of the mechanism of traumatic luxations.

One or both testicles, normally descended into the scrotum, may be forced into unusual ectopic locations by severe trauma directed against the scrotum, by sudden violent muscular efforts, by the pressure of a truss or by artificially applied means of self-mutilation.

Muscular effort as a cause of displacement has been questioned by some but admitted by others. We believe that a congenital anomaly of the testis or its enveloping fascia may often be present and form a predisposing background. However the actively operating force can be exerted by the cremaster, Dartos and abdominal muscles. Several cases of this kind are included which may be criticized but we believe that they are true effort luxations.

Von Bruns is credited with the first well presented study of this condition in 1884, and is much quoted. He published a case of traumatic luxation into the pubic region and cited the cases of Salzmann, Hess, Partridge, Godard, LeDentu and Maas.

Probably the earliest case of traumatic testicular dislocation recorded was that of Claubry published in 1818. Other early reports were made and many publications have appeared since, notably the extensive studies of Richet (1886), Franz (1895), Fajole (1896), Nicholas (1899), Klein (1906), Poisson et Lerat (1912), Sebileau et Descomps (1916), Margottini (1923), Demel (1926) and Alyea (1929).

While the congenital ectopic testis occurs in 0.1 to 0.3 per cent of subjects in general and is not at all infrequent, the traumatic luxation of the testes is quite rare. Alyea, of Baltimore, in 1929, was able to collect only 23 cases from the literature and added 2 of his own. We have found 92 cases in a review of the literature and another case of our own in which the testis was dislocated into the pubic region.

When we remember the enormous number of civil and war injuries constantly taking place, it is astonishing that there are so few testicular luxations. For instance, Otis recorded 586 war wounds in the Civil War involving the external genitalia among which were no traumatic luxations. Also doubtless many testicular herniations and self-mutilations have gone unreported.

The injuries producing testicular displacement were often unusually severe, but in some instances were seemingly almost trivial. Alyea found 9 of his 23 collected cases were run-over accidents, the wheel of a vehicle having passed more or less obliquely over the scrotum, lower abdomen and groin. Other cases participated in a variety of accidents.

Our collected cases gave the injuries as follows:

Run-over accidents..... 12
(Bruns, Bryn, Claubry, Conner, Guiteras, Hess, Howlett, Huddy, Jurinka, Kausch, Keith, Nicolas)

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Muscular efforts..... 15
(Beck, Chetwood, deQuirvain, Colinescu, Berchon, Frederick, Godard, Hartman, Gintrac, LeDentu, Pilliet, Schwartz, Salzmann, Staples, Terrillon)
Falls..... 14
cave-in (Delobel)
fall from horse (Gaston de St. Ybars, Trecourt, Donovan and Ortz)
from a train (Konig)
fell from height (Kaisin, Ollivier d'Angers, Voillemeier)
on sidewalk (Schonholzer, Kornfeld)
fall against edge of table (Simpson)
fell astride (Franz, Richet, Authors' case)
Saddle injuries (Hamilton, Partridge, Fajole, Schenjius, Broca)..... 5
Miscellaneous injuries..... 28
leaped a ditch (Thompson)
log fell on patient (Gaulden, Summerhayes)
gored by bull (Christian, Garny, Wolf)
coitus (Salmuth)
pierced by a hook (Cintrat, Snell)
caught between rollers (Golden)
caught in machinery (Tournus de Gonets)
caught in pulley (van Hassel)
gunshot injuries (Mauclaire, Girerd, Walther)
operation injuries (Malgaigne, Young)
Traumatic conditions
(Themoin, Robert deLigny, Maas, Margottini, Montanari, Papos (2), Renssen, Curling, Delpech, Foucard)
Artificial luxations to escape military service in several cases (Dombrowski 7, Krische)
Truss injuries to both congenital ectopia and acquired anomalies..... 10
(Chassaignca, Szymanovsky, Kocher, Gruber, Vidal de Cassis, Katzenstein, Ziebert, Lee, Lecomte, Gillette and Michon)

It seemed unusual, even peculiar, that such a small number of luxations should have occurred; especially when, in the long past, there undoubtedly must have been a large number of known and unknown injuries involving the scrotum and its contents. We tried to explain this discrepancy by experimental research on animals, attempting to determine the effect of force exerted upon the scrotal contents and the mechanism of traumatic displacements.

The fascial relations of the lower abdomen and scrotum are highly important. The superficial fascia of the abdomen has an outer subcutaneous layer, called Camper's fascia, and a deep layer called Scarpa's fascia which has attachments in the inguinal, pubic and mid-abdominal regions and extends downwards over the thigh, scrotum, and perineum. In the scrotum it becomes the Dartos and in the perineum, Colle's fascia.

The deep fascia (f. profunda) of the abdominal wall, when present, closely covers the sheath of the external oblique muscle, and fuses with the aponeurosis of the external oblique then extends down over the scrotum as the fascia spermatica externa. This fusion prevents the scrotal contents from burrowing beneath the deep fascia and aponeurosis and is strongly attached at the groin and at the midline of the abdomen. It is sometimes called the intercolumnar fascia.

The cremasteric muscle and fascia are derived from the internal oblique muscle. The fascia infundibuliform (propria) is derived from the transversalis fascia. These two fascial layers pass down over the spermatic cord and testis to form the fascia spermatica media (cremaster), and the fascia spermatica interna (f. propria).

The testis and cord are covered by the two layers of the tunica vaginalis. The testis is held attached firmly to the bottom of the scrotum by the gubernaculum testis which limits the motions of the testis, and compells penetration of the internal spermatic fascia (cremaster and propria) by the testis, before complete freedom of motion can be attained by the testis.

Several theoretical considerations may be mentioned:

1. The testis, encased in the tunica vaginalis and the internal and median spermatic fascia, is freely movable inside the external spermatic fascia, and, limited by its gubernaculum, may extend as far as the external inguinal ring and the fascial attachments at the groin.

2. Since the testis is covered by the tunica vaginalis, and the internal median and external spermatic fascia, it follows logically that to reach the subcutaneous tissues, the testis must penetrate these fascia.

3. Should the external spermatic fascia, or aponeurosis, alone be ruptured and the gubernaculum testis torn from its scrotal attachment, the testis would be free to

locate anywhere on the surface of the deep fascia and aponeurosis, above or below Poupart's ligament. This misplaced testis would be covered by the unopened internal and median spermatic fascia (cremaster and propria).

4. Should the internal and median spermatic fascia alone be ruptured, the liberated tunica covered testis would be free to lie anywhere within the external spermatic fascia, below the inguinal ring. The testis can enter the inguinal canal but cannot pass outside of the external spermatic fascia.

5. Should the internal, median and external spermatic fascia all be ruptured, the testis, covered by the tunica vaginalis, could locate anywhere on the surface of the deep fascia (aponeurosis) on the abdomen or perineum, under Scarpa's or Colle's fascia.

We believe that the majority of traumatic luxations have been of this last variety, the testis retaining only its vaginal tunics (Keith, Alyea).

6. A superficial subcutaneous position can be reached only when the misplaced testis has penetrated Scarpa's or Colle's fascia, as well.

7. Because of the firm attachments of Scarpa's fascia and the aponeurosis at the groin and vertically along the midline of the abdomen, the misplaced testis will not pass the midline and will lie above or below Poupart's ligament.

8. The testis with all its three fasciae intact may bend the cord and evaginate the fascia and lie anywhere under the superficial fascia with no rupture of fasciae. This form should reduce easily until adhesions form to fix the testis in place.

Under ether anesthesia the testicles of dogs were severely traumatized by squeezing, pulling and pushing, with the full strength of the unusually muscular hands of a laboratory attendant. The testes could be moved freely into almost any subcutaneous ectopic position, adjacent to the inguinal region; but when released, promptly and spontaneously returned to their original scrotal locations. In no instance, with the hands alone, were we able to force a testis from its envelopes, or with its envelopes, into permanent subcutaneous displacement.

Only when the tissues overlying a testis were directly incised with a scalpel while held by the hand in ectopia, were we able to keep the testis in a permanent subcutaneous dislocation. By this means we were able to place a testis in permanent suprapubic displacement, where it still remained two months later when it was reexamined. Its size was greatly reduced.

Dissection revealed that the testis lay on the surface of Scarpa's fascia, and that this and the deep fascia had both been opened. The testis had escaped through the fascial wound, and lay superficially in the pubic region. The moment the testis passed through the fascial openings onto the abdominal wall it was held in an ectopic position and remained there indefinitely. The constriction produced by the severed fascial fibers upon the spermatic cord interfered with the circulation of the testis, which therefore had atrophied.

Several other experiments were made. In one dog the testis was held in ectopia and all the tissues overlying it were incised leaving only the tunica vaginalis intact. Then the incision in Scarpa's fascia was united and sutured over the testis. The testis remained in ectopic position on the deep fascia.

In another experiment the testis was pushed up into the groin, and both the aponeurosis and external spermatic fascia were incised from above Poupart's. The testis remained in abdominal ectopia on the deep fascia (aponeurosis).

In another instance the skin and Dartos, external, median and internal spermatic fascia were incised in the upper part of the scrotum. The testis, covered by tunica vaginalis, was herniated at once.

The inguinal region and the scrotum of a dog were placed in the metal letter-press and subjected to enormous pressures. The right testis ruptured its fascia, the left did not; the left one reduced, the right did not.

Several other various experiments and cadaver dissection substantiated our conclusions.

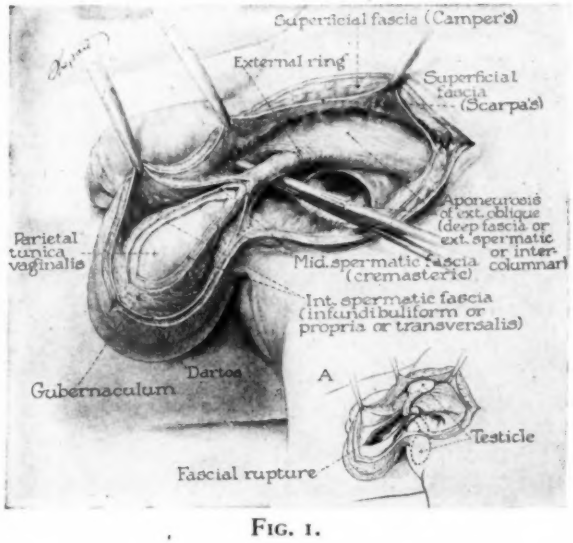

Fig. 1.

Clinically complete testicular eventration occurs through a wound involving all the layers composing the walls of the scrotum, skin, Dartos, external spermatic, cremasteric and infundibulaform fascia. Rarely, even in herniation of the testis, is the tunica vaginalis torn, and then only the peripheral layer.

We have been unable to accumulate much clinical evidence to support our theoretical considerations and experimental results, except in the numerous cases of testicular herniation through the scrotal wound.

The condition of the tunica vaginalis has received some consideration in the literature. Some authors noted that the displaced testis was covered by the unopened tunica vaginalis (Keith, Alyea), while others recorded the opened tunic (Young, Wolf). Alyea stated that in all his cases except one the tunic remained intact. In Keith's case the testis is described as lying under the superficial fascia. In the majority the testis is described as lying subcutaneously or superficially but few exact descriptions have been made.

Anyway, it is quite evident that it requires a strong force acting upon a more or less fixed gland, before rupture or permanent displacement can occur. Franceschi of Florence, Italy, estimated that to rupture the tunica albuginea of the testis, and

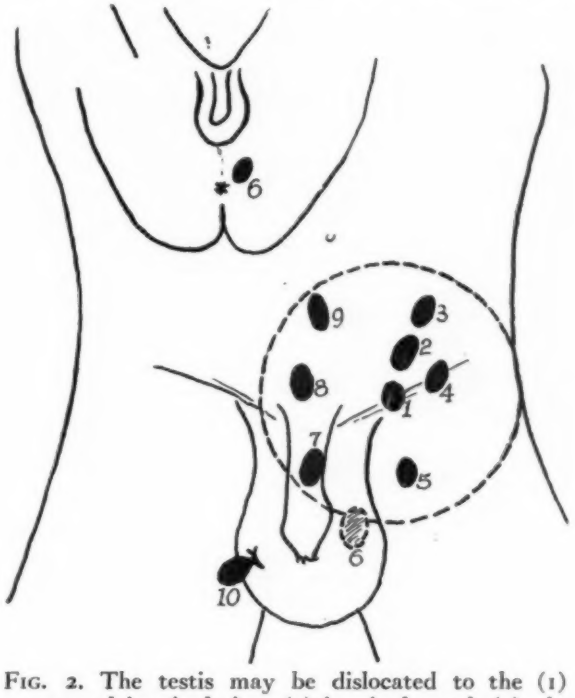

Fig. 2. The testis may be dislocated to the (1) external inguinal ring, (2) inguinal canal, (3) abdominal cavity, (4) superficial inguinal region, (5) crural (thigh) region, (6) perineum (pre-anal) region, (7) penile region, (8) pubic and suprapubic region, (9) superficial abdominal region and (10) scrotal herniation.

to produce herniation of the seminiferous tubules required a force of at least 50 kilos. Kocher used all the force of which he was capable on the testis of a dog and was unable to cause an appreciable lesion of the gland. Monod, however, by fixing the gland with forceps, was able to traumatise it and to produce intraglandular hemorrhages, with subsequent atrophy of the testis. Rigel was successful also in producing atrophy by trauma.

These facts would seem to show, that despite the great mobility and high resistance to injury, the testis and its envelopes can be ruptured, if the properly directed force is great enough, and the organ can be forced from its usual position.

The action and direction of the force causing the luxation is important. In the run-over accidents, the force of the wheels in most cases was applied obliquely across

the scrotum, groin and lower abdomen, thus exerting an upward oblique squeezing and crushing action. In the lifting and

Fig. 3. Traumatic pubic luxation of the left testis.

effort accidents, the sudden action of the abdominal, Dartos and cremaster muscles played the chief role. In yet other cases, a direct blow to the parts, or falling astride, would be comparable to the strong runover force exerted by a wheel. Some causative forces were indirect in their action, as in those resulting from a fall, and should probably be included with the effort accidents. Penetrating and cutting accidents are self-explanatory.

The external inguinal ring may be taken as the center of a circle; the radius may be a length equal to that of the extra-abdominal portion of the spermatic cord. The traumatically dislocated testis may occupy any location within the region represented by this circle, particularly along its circumference. It may lie in any of the positions assumed by the congenital ectopic testicle (Fig. 2).

Should the external inguinal ring be relaxed or opened widely enough, or a hernia inguinalis be present, or the testis be hypoplastic or atrophic, the properly directed trauma or the cremasteric contraction may force the organ up into the inguinal canal, or even farther on into the abdominal cavity, the "ectopie en retour." A poor attachment of the testis to the bottom of the scrotum, or "testicules flottantes," will favor this inguinal displacement.

Usually, however, the external inguinal ring is firmly closed and the testis must pass in the direction of the compelling force into more or less distant subcutaneous positions, or through a scrotal wound to the exterior.

Traumatic luxations of one or both testicles may take place into the following regions:

Site	*No. of Cases*
Inguinal canal or the abdominal cavity	23
Femoral canal	0
Crural canal	0
Subcutaneous tissues of	
Pubic and lower abdominal regions	11
Penis	4
Inguinal regions	10
Perineum	8
Thigh and crural regions	1
Hernia testis	27
Dislocation action of a truss	6
Artificial self-mutilations with luxation of testis	2
	92

The age was mentioned in 51 cases as follows:

Age Years	*No. Cases*
Under 10	2
11–20	15
21–30	16
31–40	6
41–50	5
51–60	6
61–70	1
	51

The greatest frequency occurred from ten to thirty years of age.

The duration of the condition in 31 cases ranged from twelve hours to twenty-five years.

Duration	*No. Cases*
½–27 days	10
½–5 months	7
½–25 years	14
1–12 years	12

Of 47 cases, 41 were operated and 6 were reduced without operation.

The occupation was noted in 44 cases as follows: Soldiers 12; horsemen 7; farmers 4; gymnasts, 4; laborers, 3; teamsters, 2; and one each, sailor, messenger, cook, medical student, tailor, salesman, bicycle-rider, college professor, brakeman, miner, collier, wrestler.

Dislocation of the testis into the superficial subcutaneous tissues of the pubic and suprapubic regions was recorded in the cases of Bruns, Bryn, Claubry, Conner, Donovan et Ortiz, Nicholas, Popow (2), Salzmann, Wulfius, and our own case, a total of 11 cases.

We are interested most particularly in the displacement to the pubic and lower abdominal regions, because our own case was of this variety.

A short synopsis of these cases follows.

Case I (Claubry). A soldier, twenty years of age, fell from a wagon in May, 1809. The wagon wheel passed over his scrotum and lower abdomen as he lay on his back and caused severe contusions. Three months later he appeared at the Military Hospital with both testes in the suprapubic region near the internal pillars of the oblique muscles. He complained of pain and was compelled to bend forward when walking. No treatment was mentioned.

Case II (Wulfius). A man, sixty years old, received a violent blow and his testes were dislocated into the pubic region. No other details were given. (Quoted by Godard.)

Case III (Salzmann). A man of fifty-five years had a slightly movable atrophic testis lying subcutaneously on the lower abdomen above Poupart's ligament at the level of the os pubis. He had sustained a luxation of the testis twenty-two years before during gymnastic exercises.

Case IV (Conner). A teamster in the U. S. army was injured December 17, 1861, the wheels of a heavy wagon having passed over the inguinal and scrotal regions. He came to the Columbia Hospital, at Washington D. C. There were contusions of the penis and scrotum and the right testis had been forced into the pubic region to the left of the midline. Closed reduction was successful three days later.

Case V (vonBruns). A man of thirty-three years was runover by a wagon in November, 1881, the wheel passing over his scrotum and lower abdoman. He suffered from shock and was unable to rise. When Bruns saw him four weeks later, there was suppuration, a pelvic fracture and the apparently normal right testis had been dislocated into the pubic region but reduction was impossible. It was unchanged when seen again one and one-half years later.

Cases VI and VII (Popow). The left testis was dislocated into the pubic region, lying at the root of the penis. It was normal in shape and sensation, and was in normal relation to its epididymis. No history or treatment were given, but a photograph was shown.

Another similar case was found in a tailor in Moscow, who had been injured in childhood. No details were noted.

Case VIII (Nicolas). A man of thirty-two years was run over by the wheel of a heavily laden wagon and he lost consciousness. The scrotum was ecchymotic and swollen and the suprapubic region contused and swollen. The left scrotum was empty and the tender testis was found lying freely movable in the pubic region. It was reduced with excellent results by open operation.

Case IX (Bryn). A man of fifty-nine years was run over by a heavily laden wagon, a wheel passing obliquely over the scrotum and right lumbar region. When seen two days later, both testes were walnut sized and dislocated, lying subcutaneously on either side of the symphysis pubis. The lower part of the abdomen was tender. A hydrocele and a hematocele also present were reduced easily without operation.

Case X (Donovan and Ortiz). A man fell from a horse in September, 1920, and felt a sharp pain in the left scrotum, fainting on trying to arise. The left testis had been dislocated into the pubic region. Two months of conservative treatments were without results; horseback riding still caused pain, nausea and vomiting. The testis was then replaced successfully into the scrotum by open operation. The epididymis was in normal relationship to the testis.

Case xi (Authors' case). A Polish teamster, forty-seven years of age, married, six children, entered the Central Free Dispensary at the Rush Medical College, December 28, 1933, complaining of urethral discharge, suprapubic distress, burning on urination, nocturia every two hours and sacral backache, all of two months duration. A suprapubic mass had existed for twelve years and an acute swelling for six weeks.

Previous History. He had had a gonorrheal infection without known complications twenty years previously, in 1914; influenza and pneumonia in 1916; a fractured foot in 1920; sore throat and obstructed nasal passages frequently for many years; deafness in right ear, poor teeth and poor sight for several years; poor appetite for two months. There had been no other pathology of the bowels, heart, lungs, abdomen or extremities. Both testes had descended into the scrotum normally and his sexual desire and ability were normal.

He was injured in 1921, while attempting to lift a large drum of oil onto a truck the barrel slipped and he fell heavily astride its edge. The scrotum and its contents were injured, and the pain was so severe that he doubled up and was forced to sit still for about half an hour. He did not become unconscious. The scrotum and suprapubic region became badly swollen; there was some dysuria, the three urinations following the injury were grossly bloody, but no urinary obstruction occurred. The left scrotum was empty, the skin bruised and the left testis lay in the suprapubic region forming an egg sized swelling, which at first was painful. Later it gave the testicular sensations and consistency. It was freely movable but not reducible, and did not appear to be reduced in size. There were no chills or fever.

After the injury he went home and for seven weeks applied hot applications locally and rested in bed. The swelling and pain disappeared soon except for the suprapubic testicular tumor mass which caused no disturbance. Occasional light trauma would cause suprapubic pain. This condition has existed unchanged for twelve years.

In April, 1933, three days after lifting a heavy barrel, he developed severe sudden lumbosacral pain, burning on urination and urethral discharge. He denied extramarital exposures. Two months prior the suprapubic testis became swollen and tender, associated with a severe backache. The skin and subcutaneous tissues in the suprapubic region became swollen, tender, red and hot. Hot applications reduced the swelling in a few days. He denied infections and knew of no causative factors. No doctor was consulted.

The family history was essentially negative. There were no familial, hereditary nor personal pathological idiosyncrasies.

Physical Examination. The patient was a medium sized man of forty-seven years of age, apparently in good health. The right ear was deaf; the eyesight and teeth poor. The chest, heart, abdomen and extremities were negative. Mild inguinal adenopathy was present.

There was an acute urethritis. The smears of the urethral pus showed numerous gram negative intracellular diplococci, morphologically gonococci. Cultures and complement fixation were not made.

The suprapubically dislocated testis was involved in an acute epididymitis, which extended to the skin and subcutaneous tissues causing a red and tender tumefaction. The prostate and seminal vesicles were enlarged and harder than normal. Both urine glasses were cloudy with pus. The Wassermann test was negative.

A diagnosis was made of acute urethritis, anterior and posterior, gonorrheal; acute left gonorrheal epididymitis, old traumatic luxation of the left testis, acute prostatitis and seminal vesiculitis.

Appropriate treatment for the acute infection was instituted until cure was established. The patient refused operation and disappeared.

Dislocation of the testis into the inguinal canal or abdominal cavity occurred in the cases of Beck, Herchon, Calinescu and Gomoin, Frederick, Godard, Gintrac, Hawkins (2), Hamilton, Konig, Karnfeld, Lee, LeDentu, Schenkius, Schonholzer, Salmuth, Schwartz, Terrillon, Pilliet, Vidal de Cassis, Maas, Renssen, and Christian; 23 cases in all.

Doubtful cases of this kind, which might have been traumatized congenital ectopia, or which furnished too few details, or in which the original records were unavailable, are the following: cases of congenital ectopia subjected to trauma are those of LeFort, Chetwood, Christian, and perhaps

Lecomte. We were unable to locate Maas' case records, or those of Renssen, yet both are quoted as traumatic luxations. Very few details were obtainable in the cases of Berchon, Gintrac, Schenkius, Salmuth and Schwartz; yet we have no doubt that these were true traumatic dislocations, since they are quoted as such repeatedly by reputable authors.

Case xii (Berchon). A man of twenty-one years was sent to the French Frigate Renommée at Brest where examination revealed the following facts. His testes had descended into the scrotum normally. At the age of fourteen years, while descending a ladder he misstepped and the left testis passed back into the vicinity of the external inguinal ring and caused pain. The symptoms subsided after a short time without treatment. A truss was tried on a mistaken diagnosis but proved too painful. He experienced pain on exercise and lifting. No specific treatment was given. This was an effort trauma.

Case xiii (Beck). A messenger, twenty years of age, contracted gonorrhea in September, 1879. On October 14 while lifting a bag of linseed weighing 112 pounds it slipped and he attempted to hold it by unusual exertion. He felt a sudden severe pain in his back and felt something give way. The left testis disappeared into the left inguinal region, forming a painful swelling in the inguinal canal, three inches in diameter. Ice applications reduced but did not remove it. Two days later the right testis disappeared from the scrotum. Both had been normally descended. Gradually the right testis descended, reaching the scrotum by Oct. 28 or 29, twelve or thirteen days later. The left testis had not descended by January 9. No treatment was given.

Case xiv (Calinescu et Gomion). A man of twenty-two years had traumatic retraction of a scrotally located testicle into the inguinal canal where it remained one and one-half years, reducible by force or effort. The epididymis was separated from the testis. A short diverticulum of peritoneum was found to contain the testicle. Castration cured the condition.

Case xv (Frederick). A cook, twenty-three years of age, was running with a pan of ashes when his foot slipped. He felt pain in the right inguinal region, which became swollen. A large external inguinal ring permitted the right testis to be retracted into the inguinal canal by strong cremasteric contraction. The testis was easily reduced into the scrotum. Several similar attacks occurred and compelled operation which was successful.

Case xvi (Godard). A medical student of twenty-three years of age had had both testes in his scrotum until he was ten years old, when without trauma, effort or other known cause, the left testis returned into the left inguinal canal. The pain subsided after rest and local applications. At twelve years of age after a long walk, the pain recurred. Since then he has had no trouble. Examination revealed an empty left scrotum and the left testis lay at the inguinal ring. No hernia was present. Probably this was an effort luxation on a congenital background.

Case xvii (Gintrac). He saw a testicle, already in descent, return into the inguinal canal accompanied by severe pain, following sudden effort while exercising at gymnastics. This was a true effort luxation, according to Kocher.

Case xviii and xix (Hawkins). A man of twenty-four years was struck by a locomotive. Seven days later he was found to have a fracture of the ilium, the left scrotum was empty and the left testis was displaced into the left inguinal canal. The testis was replaced into the left scrotum successfully by an open operation.

A boy of eleven years was struck by a trolley car and thrown against the curb. He was found to have a lacerated wound over the pubic region in which the penis was imbedded. The penis was denuded of its skin in the region of the corona. The right testicle was displaced into the right inguinal canal, but was reduced successfully by operation.

Case xx (Hamilton). A soldier, while riding a horse bareback, was thrown on the withers and experienced severe pain in the right inguinal region. The right testis had passed up into the right inguinal canal.

Later while straining at stool the right testis disappeared into the abdominal cavity. The right inguinal ring was open but no hernia was present. No treatment was recorded.

Case xxi (Konig). A young salesman fell from a train. Both testes were dislocated into the inguinal canals with pain and shock. Closed reduction failed.

Case xxii (Kornfeld). A farmer of twenty years had had both testes in the scrotum

originally. He fell, landing on the scrotum and perineum, and experienced severe pain. The right testis which was dislocated into the inguinal canal was reduced successfully by open operation.

Case xxiii (Lee). A young man had been wearing a truss for a left oblique inguinal hernia. The left testis disappeared, the truss having forced it into the inguinal canal. Removal of the truss permitted the testis to reappear into the scrotum.

Case xxiv (A. LeDentu). A male excavator, age twenty-one years, entered l'Hôtel-Dieu, February 22, 1869. While making a considerable muscular effort the right testicle returned to the inguinal region, causing severe pain in the groin, colic, vomiting, enlarged abdomen, with elevated pulse and respiration. One end of the testis was engaged in the external inguinal ring. This condition of strangulation persisted three days, until February 25, then subsided, and the testis could be reduced. Both testes were in normal positions before the effort.

Case xxv (Salmuthius). Both testes passed back into the inguinal canal during a violent coitus.

Case xxvi (Schonholzer). A boy, sixteen years of age, slipped on the pavement and fell down. He felt a sharp pain in the right inguinal region. It was found that both halves of the scrotum were empty. The right testis had passed through the ring and canal into the abdominal cavity and the left into the superficial inguinal region. Because of repeated attacks of pain, the right side was operated and the right testis replaced in its normal position. At operation the testis was found in a peritoneal pocket and in a state of torsion (360°). The author thought that congenital ectopia was originally the base of the trouble.

Case xxvii (E. Schwartz). Sudden effort caused retraction of a regularly descended testis into the inguinal canal. Quoted by Le Dentu et Delbet as a true traumatic luxation.

Case xxviii (Schenkius). A man on horseback had his left testicle forced into the inguinal canal by the pommel of the saddle. It remained there irreducible but the severe pain compelled an operation. The patient died. At autopsy the testis was found under the peritoneum and adherent to the deep abdominal muscles.

Case xxix (Terrillon). A laborer, forty-five years of age, was married and had a family. He never had had a venereal disease. Both testes formerly lay in the scrotum. He entered Charité Hospital in Paris, December 14, 1883, because of pain in the groin.

Two months previously, while lifting an iron bar he felt severe pain in the left groin and fainted. The left testis had passed up into the left inguinal region and was tender. The next day the testis became inflamed and swollen, and the patient exhibited signs of strangulated hernia (vomiting, tender abdomen, constipation) which persisted for eighteen days. After bed rest for three weeks he improved, but pain was present on standing.

Castration of the left testis February 2, 1884, cured the condition. The testis and epididymis were found to be fibrotic and atrophic.

Case xxx (Pilliet). A man of twenty years had gonorrhea and visited Dr. Pilliet. During athletic exercises seven years before, the right testis had passed back into the inguinal canal and remained there and became infected with gonorrheal epididymitis. Eventually it atrophied and fibrosed. The pain compelled Pilliet to perform castration of the right testis. Up to eleven years of age both testes were in the scrotum.

Case xxxi (Vidal de Cassis). He described a case of left inguinal hernia in which a truss applied to the hernia had drawn the left testicle up to the left inguinal region where it became fixed. The external ring was open readily admitting the finger.

Case xxxii (Maas). A case of the return of the testis to the inguinal region due to trauma was quoted by Konig and others.

Case xxxiii (Renssen). Quoted as a true traumatic luxation.

Case xxxiv (Christian). A boy of fourteen years was gored by a buffalo and was examined eighteen hours later. The small intestines extruded from an abdominal wound and he was in shock. The gut was resected and replaced and the wound closed. The right testis was dislocated upwards to the abdominal cavity into which it hung by a short pedicle. It was left in place. The patient recovered. (It was probably an undescended testis with a short pedicle).

The dislocation of the testicle into the superficial subcutaneous inguinal regions occurred in the cases of Ahern, Gaulden, Hess, Jurinka (hip joint) Keith, Margot-

tini, Poisson et Lerat, Salmuthius and Walther; 10 cases in all.

The Montanari case record was not available, but probably belongs here, according to Demel.

Chassaignac's case was a truss dislocation preventing the descent of a probable congenital undescended testis.

Case xxxv (Ahern). A college professor, twenty-seven years of age, was seen April 4, 1898, complaining of groin tumor and pains. Five years prior, without effort, trauma or other known cause, the right testis was displaced into the right groin near the external inguinal ring. Previously the testes had both been normally placed in the scrotum. In January, 1898, after a long walk, the right groin became painful and swollen, and lumbar pain appeared. He became progressively more and more emaciated.

Sarcoma of the right ectopic testis was diagnosed.

The tumor was removed by open operation on April 22, 1898. The patient was not relieved of his symptoms and died in June, 1898.

Histological examination revealed that the testis and cord were invaded by encephaloid glandular carcinoma.

Case xxxvi (Gaulden). A brakeman on a log train, thirty-two years of age, was thrown from the railroad car and pinned between two logs. He sustained a broken right leg and abdominal compression. Two hours later Gaulden found him in shock with painful discolored groins and scrotum, with masses in both inguinal regions which were painful, dislocated testes. The right one was reduced on the third day. The left testis was operated on the eighth day and replaced in the scrotum. The vasa and epididymes were uninjured.

Case xxxvii (Hess). A soldier of thirty-one years of age fell from a cannon carriage and a wheel passed over his body, left hip and leg, while he lay on his stomach with a saber between his legs. He experienced severe scrotal pain, felt faint and could not stand. Two days later when seen by Hess there were swollen and contused scrotum, left thigh and hip. The right scrotum was empty and the right testis lay in the right inguinal region. Reduction was successful on the fourth day.

Case xxxviii (Jurinka). A man of forty years was struck and run over by a wagon and the left leg and hip injured. The scrotum was swollen and the left testis had disappeared. An exploratory operation opened a hematoma and the testis was found in the cavity of the left hip joint. Atrophy and injuries of the testicle compelled castration.

Case xxxix (Keith). A farmer of West Virginia, on April 1, 1898, was run over by a horse cart, the wheels passing diagonally across the pelvic region. The right scrotum and groin were swollen and bruised, and the right testis dislocated into the right inguinal region subcutaneously. Closed reduction attempted two days after the accident was not successful. The right testis and epididymis were replaced into the right scrotum by open operation on the twenty-seventh day. They had been found lying in the tunica vaginalis under the superficial fascia.

Case xl (Margottini). A man of forty-one years was injured and the right testicle passed up to the inguinal region. While leading a horse, the animal reared back and knocked the man against a wall, striking his testis, lower abdomen and upper thigh. Pain and swelling occurred in the right scrotum and inguinal regions. The right testis lay in the inguinal region. He was cured by operation.

Case xli (Walther). A soldier serving in the Peronne region was shot in the groin, with injury to the penis and a scrotal wound which permitted a hernia of the left testis. An extensive scar in the groin formed by the healing of the injuries caused retraction of the testis and bending of the penis to the left.

Case xlii (Montanari). Demel quotes this case as an abdominal traumatic luxation of the testis.

Case xliii (Salmuthius). He tells of a child who was kicked in the scrotum and the testis passed into the groin. Fever developed and the child died. No details are given.

Case xliv (Chassaignac). A man of twenty-one years, a student soldier at the school of St. Cyr was seen July 13, 1851. His testicle lay in the inguinal region and had been mistaken for a hernia, for which he had worn a truss for ten years. Being held in place for so many years, it now could not be reduced to the scrotum or to the abdomen, because of adhesions.

Case xlv (Poisson et Lerat). A farmer, eighteen years old, entered Nantes Hospital, December 11, 1911, for sickening pains in the right inguinal region. He had been kicked in

the scrotum by a boy at play when six years of age. Up to the time of injury the left testis had been normally placed in the scrotum. When injured the left testis had passed into the superficial inguinal region and had been wrongly diagnosed as hernia. This inguinal testis became swollen once after a long walk and again after a blow from an elbow. Open reduction was done successfully December 13, 1911, and the testis appeared to be normal.

The dislocation of the testis into the subcutaneous regions of the perineum occurred in the cases of Broca (Klein), Fajole, Franz, Hartmann, Liddon (Partridge), Senenko, Simpson, and Thompson; 8 cases in all. The testicle in the Senenko case was not firmly fixed in the scrotal sac, probably belonging to the type of "floating testis."

Incomplete data renders the cases of Fajole and Broca dependant upon quotations since we were unable to obtain the original publications. They were both undoubtedly true traumatic luxations.

Case xlvi (Broca). A boy of twelve years was injured by the saddle of a bicycle. The testis was dislocated into the perineum.

Case xlvii (Franz). A soldier, twenty-two years of age, fell about 3 meters, landing astride upon a beam of the framework of a barn. He sustained a large wound involving the urethra, scrotum and perineum. Blood was found in the urine three weeks later. He was bedridden for four months. The right testis had been forced subcutaneously into the perineum and continued to be painful, especially on sitting, walking, lifting or exercising and was not reducible. Operation was refused.

Case xlviii (Fajole). A perineal (proanal) dislocation of the left testis in a horseman, the testis being in the midline in front of the anus.

Case xlix (Hartmann of Detmold). A soldier had both testicles in his scrotum when injured on March 28, 1894. During military maneuvers, while he was walking down a mountain side, he felt a sudden severe pain in the lower right inguinal region, as if something had given way. The next morning the right scrotum was empty and the right testis lay in the perineum to the right of the midline, 4 cm. in front of the anus. The epididymis had separated from the testis and the vas deferens was palpable. A tight belt and abdominal compression were given as possible causes.

Case l Liddon (Partridge). A soldier had served in the horse artillery two years before. While riding, he sustained a saddle injury and fell from the horse. He vomited. Next day he observed that the left testis lay one inch in front of the anus in the perineal tissues, was painful and one-half the size of the right organ. The left testis was replaced by open operation, but slipped back into the old perineal position. It was necessary to castrate to obtain cure.

Case li (Senenko). A strong man of twenty-four years had his right testicle in the subcutaneous tissues of the perineum, about 2.5 cm. in front of the anus for the past several years. Formerly both testes lay in the scrotum, but the right one could be moved temporarily into the inguinal canal.

Several years ago he received a blow in the inguinal region, while the testis was highly placed. He experienced severe inguinal pain and lay in bed with cold compresses for three days. He found the right testicle in the perineum where it has remained, without disturbance ever since. (This was an injury sustained by a probable floating testis.)

Case lii (Simpson). A man aged twenty-three years, entered the Episcopal Hospital on Nov. 7, 1913. Twelve hours before he had collided forcibly with the corner of a table, striking his scrotum. Severe testicular pain, nausea and vomiting occurred. The scrotum and perineum were ecchymotic and tender, the right scrotum was empty, and the right testis lay in the perineum subcutaneously. The perineal testis could be easily reduced, but at once recurred. The patient left the hospital in fear of operation.

Case liii (Thompson, Paducah, Ky). An infantry soldier, in May, 1862, leaping over a ditch sustained a painful enlargement in the left groin and perineum. He was granted disability discharge in July, 1862, because of pain and swelling in these parts.

Examined again in February, 1866, the left testis was found located in the perineum. Previously both testes lay in the scrotum. He was having attacks of epileptiform spasms on exertion which were relieved by flexing a joint or by motion. The perineal testis was tender and painful. No treatment was recorded.

Dislocation of the testis into the subcutaneous tissues of the penis (penile type)

occurred in the cases of Howlett, Huddy, Guiteras-Lewis, J. D. and Kausch; 4 in all.

Poupart's case, often quoted, was congenital ectopia and does not belong here. Alyea had a crural dislocation.

Case liv (Howlett). A laborer, sixty-five years old, was seen at the Hull Royal Infirmary in 1886. Four years before he had been knocked down by a cart and a wheel had passed over the scrotal region, and the left side of the abdomen. He complained of spinal symptoms. The left testis, absent from the scrotum, was found lying subcutaneously on the left side of the shaft of the penis. The epididymis was separated from its testicle which lay opposite the external inguinal ring. The testis was of normal size and sensation and produced no symptoms. No erections occurred. No treatment was directed to the dislocated testis. Death occurred in 1889 but no autopsy was made.

Case lv (Huddy). A man of twenty-three years of age was seen at the Dudley Road Hospital, Birmingham, on February 21, 1928. Twenty-five days before he had been run over by a motor lorrey, the wheels passing over his pelvic region. The run-over parts were bruised and swollen and the left testicle was dislocated subcutaneously to the ventral aspect of the penis. Because of adhesions the testis was irreducible, so open operation was done and the testis successfully replaced into the scrotum.

Case lvi (Lewis and Guiteras). A piano mover of fifty-two years of age, was run over by a cart. The wheel passed between his legs and upwards over the pelvis, groin, flank and thorax. He sustained fractures of the sixth and seventh ribs and contusion of the hip and scrotum. The scrotum was swollen and he suffered severe pain for about one week. He remained in bed five weeks, on standing he was weak and nauseated, with pains in the hip and penis. The left testis was found dislocated to the under surface of the penis, and the epididymis had been torn from the testis and remained in the left scrotum. Operative replacement was successful.

Case lvii (Kausch). A man of twenty years of age, was hit by an automobile and sustained inguinal, pubic and scrotal injuries. A large hematoma formed in the scrotum and perineum. Several days later, after the swelling had subsided, the left testis was found dislocated subcutaneously to the left side of the shaft of the penis. Under a mistaken diagnosis, biopsy material was obtained by incision and testicular tissue discovered. Closed reduction failed, so the left testis was replaced by open operation with excellent results.

Case lviii (Alyea). A young man was injured in an automobile accident five months before his admission to the Brady Urological Institute, Baltimore, on September 10, 1928. He had suffered from fractured pelvis, dislocation and fracture of the head of the right femur, left direct inguinal hernia, laceration of the perineum and dislocation of the right testis to the inner aspect of the thigh. This testis was movable and normal in size and consistency and lay in the subcutaneous tissue over the fascia lata at the apex of the femoral triangle. Closed reduction was not possible so it was successfully reduced to the scrotum by open operation. (A crural luxation.)

HERNIA TESTIS

The extrusion of the testis outside the scrotal sac, usually through a scrotal wound, the so-called "hernia testis" has occurred in the cases of Alyea, Barthelemy, Cintrat, Curling, Delobel, Delpech, Foucard, Gaston de Saint Ybars, Girerd, Garney, Golden, Kaisin, Mauclaire, Malgaigne (2), Ollivier d'Angers, Robert de Ligny, Richet, Snell, Summerhayes, Trecourt, Themoin, Tournus de Gonets, Voillemier, van Hassel, Wolf, Walther and Young; 27 in all.

The original documents in several of these cases were unavailable but the cases were cited by good authorities, such as Julien, and Richet, so we feel that they may be safely included. Such are the cases of Cintrat, Foucard, Girerd, Garny, Kaisin, Ollivier d'Angers, Robert de Ligny, Snell, Trecourt.

Case lix (Alyea). A man of forty-five years of age, entered the Johns Hopkins Hospital shortly after being struck by an automobile and thrown against the curb. He was intoxicated at the time. Examination revealed alcoholic coma, comminuted fracture of the left wrist, injuries of the face and both legs, a 4 cm. long laceration of the left scrotum, through which the left testis herniated, together with

8 cm. of the cord. The vaginal envelopes were not opened. The exposed testis and cord were cleansed with mercurochrome and replaced in the scrotum. Healing was prompt.

Case lx (Barthelemy et Miramond de Laroquette). A miner, eighteen years of age, was injured while at work July 15, 1909. The scrotum was almost pulled off by a drill shaft upon which he was astride. The skin was torn off the scrotum, penis and perineum, denuding the testes. Sterile compresses were applied for about three weeks until the necrotic tissues were thrown off. Then plastic surgery and skin grafting successfully covered the testes and denuded regions. The patient left cured in two months.

Case lxi (Cintrat). He saw a case of hernia testis in the rider of a donkey, who in dismounting was pierced by the hook which supported the saddlebags. The hook tore open the scrotum and permitted herniation of the testis. This case was operated successfully.

Case lxii (Curling). He reported a case of hernia testis and cord through a triangular scrotal wound. It was reduced at once, sutured and healed within one week.

Case lxiii (Delobel). A man of fifty-two years of age was injured in a cave-in on May 21, 1888. He was taken 4 kilometers to the hospital and seen the next day. He suffered with some pain and hemorrhage but did not lose consciousness. Examination revealed a large transverse wound anteriorly in the scrotum. Both testes hung out of the wound and down between the thighs. The edges of the wound had retracted, but the cord was not strangulated. The parts were cleansed with 1 per cent carbolic acid, reduced to the scrotum and the wound sutured and drained. Suppuration occurred, but healing was complete by June 30, 1888.

Case lxiv (Delpech). A young man was taken to the hospital for hernia testis, the result of an injury. The contraction of the scrotal wound caused strangulation of the cord, with fever and vomiting. The wound was enlarged but the testis was not replaced for a short period, until the suppuration was under control. The outcome was excellent.

Case lxv (Foucard). Traumatic hernia testis, quoted by Richet.

Case lxvi (Gaston de Saint Ybars). A young man fell from a donkey, caught his foot in the halter, and was dragged along for 300 feet over rough stony terraine, before regaining his feet. The scrotum was cut by a sharp stone and the right testis hung out by its cord, extending down to the inferior third of the thigh. The scrotal wound was enlarged and the testis replaced. Despite considerable suppuration, healing took place in thirty-five days.

Case lxvii (Girerd). He mentioned one case in which the scrotum was almost pulled off but no details are given although he gives details of another case:

Mehemet Said, twenty-nine years, sustained a gunshot wound of scrotum and thigh and was seen by Girerd at Beylerby Hospital fifteen days after the battle. The right testis had herniated through a scrotal wound. Pain was constant from compression of the cord by the contracted wound. The scrotal wound was enlarged and the testis replaced by a plastic operation, with excellent results.

Case lxviii (Garny). An African colonist, thirty-six years of age, was gored three times by a bull on September 22, 1860. He was seen by Dr. Garny twenty-four hours after the accident. The scrotum was contused, swollen and the left testis herniated through a scrotal wound. Gangrene of the scrotum appeared but healed in about fifteen days. Then the testis was replaced and held in position by a plastic operation. Suppuration persisted until October 15. The patient left the hospital in good condition October 23, 1860.

Case lxix (Golden). A man of twenty years was caught between rollers in a lumber yard and his scrotum almost torn off. The testes were bared but not injured. To protect the testes they were placed in a preperitoneal pocket inside the internal ring by operation. Plastic skin surgery eventually established a cure.

Case lxx (Kaisin). A boy of sixteen years attempted to climb a wall and fell 2 meters upon a sharp stake, which opened the scrotum. Hernia testis occurred. No details are given.

Case lxxi (Malgaigne). While operating upon a multilocular cyst of the cord the testis slipped out through the wound. The wound contracted and Malgaigne was unable to reduce the testis. He consulted Amussat and Lisfranc who advised enlargement of the wound and suturing the testicle in place. Cure was established after a period of suppuration.

Case lxxii. Malgaigne had seen a similar case at the Hospital Saint Louis, Paris.

Case LXXIII (Mauclaire). A soldier was shot in the genitalia with partial destruction of the penile urethra, glans penis and scrotum. Seen at the hospital two days later, the testis, covered by cremaster muscle, was found herniated through a scrotal wound. It was cleaned and tincture of iodine applied. Seven days later it was replaced and sutured in the scrotum. A catheter was placed in the urethra for eight days, healing except for an urethral fistula. Two months later the testis was somewhat atrophic.

Case LXXIV (Ollivier d'Angers). A young villager climbed an apple tree from which he fell upon a sharp stake, piercing his scrotum and permitting herniation of the testis. No details are given.

Case LXXV (Robert de Ligny). A man sustained a large wound in his scrotum from which the right testis hung by its cord. No details are given.

Case LXXVI (Richet). On July 2, 1865, M. Cretien, a locksmith twenty-four years old, entered the Hospital la Pitié, Paris, because of a left traumatic hernia testis which had resulted from an accident received the day of entrance to the hospital. He had fallen from a platform with an iron bar in his hands, landing astride the iron bar. He felt severe pain for a few minutes, later noticing scrotal enlargement and bleeding. The penis, scrotum and pubic region were swollen and ecchymotic, the left groin was painful and the left testis and cord extruded from the scrotal wound. Unable to reduce it because of the retracted scrotal wound and severe pain, he was operated. Suppuration followed and eventually caused death.

Case LXXVII (Snell). A child had a hernia testis through a scrotal wound. The boy of twelve years was climbing a rope to the end of which a hook was attached and slipped down upon the hook, which pierced the tissues between the pubis and anus and opened the scrotum. The testis protruded.

Case LXXVIII (Summerhayes). A man of twenty years, in Punjab, Indian, was sawing a log placed at an angle of 50°, when the log fell on him, forcing his thighs together. The scrotum was torn and the testis and part of the cord extruded from the scrotal wound. The parts were replaced successfully by operation.

Case LXXIX (Trecourt, Quoted by Jullien). Reported a case similar to that of Gaston de Saint Ybars, of a man dragged over a rough ground by a donkey, with hernia testis.

Case LXXX (Themoin). A man of seventeen years developed a hernia testis as the result of a scrotal wound. It was easily replaced and the injury healed in three weeks.

Case LXXXI (Tournus des Gonets). A farmer, directing the operation of a thrashing machine, had attempted to release the transmission belt when he was caught in the machinery. His clothes were pulled off and the skin of the scrotum, penis and perineum was torn off extensively. The left testicle received a wound 3 to 4 cm. in length, through which the semeniferous tubules extruded. The left testis was castrated, the right was saved. There was much scarring of the skin of the penis and scrotum. No sperm were present in the semen. He was cured in one month.

Case LXXXII (Voillemeier). A man of twenty-five years of age, when seating himself in a carriage, wounded his scrotum 3–4 cm. on a sharp saber accidentally left there. The testis herniated through the wound. Voillemeier saw the case two days later at Cloquey's Clinic. He was obliged to enlarge the scrotal wound to effect reduction of the testicle.

Case LXXXIII (Van Hassel). A robust adult, twenty years of age, a collier, was caught between a pulley block and a piece of wood and thrown some distance. No syncope but little pain occurred. The left testis was reduced to the scrotum fifteen days later by operation and the wound healed readily.

Case LXXXIV (Wolf). A peasant was gored by a bull and was suspended on the horns for a time. Great damage was done. The tunica vaginalis was opened, the scrotal septum destroyed, the testes exposed and the penis buried in the tissues.

Case LXXXV (Walther). A soldier serving in the Peronne region was shot in the groin, injuring the penis and a scrotal wound permitted herniation of the left testis. Healing took place with extensive scar formation.

Case LXXXVI (H. H. Young). During an operation a small cut was made by mistake through the tunica vaginalis and tunica albuginea. A small fungus of the seminiferous tubules extruded and grew progressively, until the entire substance of the testis had protruded before healing occurred.

Dislocation of the testis due to the pressure of a truss acting upon a congenital

ectopia, or upon a normally descended testis has been reported in a number of instances, and should be included here as a traumatic luxation; at least when acting upon the descended organ.

Sometimes the truss was applied to an undescended testis under a mistaken diagnosis of inguinal hernia. Cases of this type were reported by Godard, Lecomte, Chassaignac and Salzmann. Von Foth in 1910, credited similar cases to Szymanowsky, Kocher, Gruber, Katzenstein and Ziebert.

Sometimes the truss was fitted to an inguinal hernia and caused retraction of the normally descended testis until it lay in an abnormal position. Cases of this kind were reported by Vidal de Cassis (Case XXXI), Lee (Case XXIII) and Walther (Case XLI).

Sometimes a truss or other form of artificial mutilation was employed to displace the testis or to produce an artificial hernia. Cases of this type are recorded by Kiche, Dombrowski, Tanfiliew and Romantzew, and Galin. Staple's case should belong here. Artificial luxation of the testis was practiced to avoid military service, particularly in Russia. Self-mutilation of this kind was effected by displacement of the testis with a truss having a long pad, and the organ held in dislocation long enough for adhesions to form. The testis atrophied as a rule. Digital dilatation of the external and internal inguinal rings and other artificially produced openings was reported by Galin to produce artificial hernia. Von Foth credited Krische with case reports and a study of this condition of artificial testicular displacement.

Case LXXXVII (Gillette and Michon). A child of eleven years of age had a left ectopic testis in the inguinal canal. The boy wore a truss which held the testis in the inguinal canal under a mistaken diagnosis of hernia. Removal of the truss permitted the testis to descend into the scrotum.

Case LXXXVIII (Godard). A perineal ectopia testis in a man of fifty-six years of age for whom a truss had been fitted twenty-five years previously to retain an inguinal ectopic testis under a mistaken diagnosis of hernia. It had slowly pushed the testis into the perineum, taking twenty-five years to do it.

Case LXXXIX (Lecomte). A man of forty-one years of age wore a truss which forced the undescended testis into the inguinal canal. He was castrated for a tumor. (Quoted by Godard.)

Case XC (Chassaignac). A man of twenty-one years of age, a student soldier at St. Cyr, France, had worn a truss for inguinal hernia for ten years. His testis lay in the inguinal region and had been mistaken for a hernia. Adhesions had rendered it irreducible.

Case XCI (Dombrowsky). The right scrotum was found empty in a soldier recruit and the right testis lay above and outside the external inguinal ring. This condition was a self-mutilation.

Dombrowsky saw 7 similar cases in recruits of the Russian Army.

Tanfiliew and Romantzew reported several cases of testis displacement due to self-mutilation. This practice is almost entirely confined to Russians. Galin reported hernias due to self-mutilation. Krische and Kiche are reported as having made a study of artificially displaced testes in Russia and had seen several cases in recruits for the army, produced by truss, bandage or ligatures.

Case XCII (Salzmann). A man of twenty-seven years of age, under a false diagnosis of hernia, had worn a truss to retain an inguinal ectopic testis. The truss pushed the testis up under the skin of the abdomen to the region of the spine of the ilium.

Case XCIII (Staples). An Indian wrestler was accustomed to retract his testes into the inguinal canal to prevent his wrestling opponents from grasping them. Wanting to marry, his prospective father-in-law refused him the bride until the testes were present in his scrotum. Staples succeeded in establishing artificial inflammation in the inguinal canal thus preventing retraction of the testes.

SUMMARY

A case of traumatic luxation of the testis into the pubic region is reported.

The mechanism of displacement is discussed and an explanation is attempted on theoretical grounds and by experimental investigations.

Eleven cases of pubic displacement are assembled, including one personal case and 93 cases of all varieties are collected.

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[*For Remainder of References see p. 40.*]

CLINICAL AND EXPERIMENTAL STUDY OF LITHOTRIPSY*

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THERE is probably no more fascinating chapter in the history of medicine than the surgery of vesical calculus. In 1726 James Douglas wrote, "Stone in the bladder is a Distemper, which, for ought we know to the contrary, is as ancient as any other to which the humane Body has ever been subject." Among the Egyptians and Hindus, cutting for stone was performed many centuries before Christ. In the Hippocratic oath is the statement, "I will not use the knife either on sufferers from stone, but I will give place to such as are craftsmen therein."

Time allows me to sketch only very briefly the main facts in the history of the treatment of stone in the bladder. The first operation to gain favor was known as "le petit appareil" or "the lesser apparatus," a perineal lithotomy popularized by Ammonius of Alexandria in the third century, B.C., and requiring only two instruments, a knife and a hook. This operation remained essentially the same until about 1520 A.D., when Joannes de Romanis of Cremona devised a better perineal operation, which was described fifteen years later by his pupil Marianus Sanctus and thus became known as the Marian operation or "le grand appareil," so-called because of the numerous instruments required. In this operation a grooved sound was first passed and the bulbous urethra opened with a lithotome. A gorget was then passed along the groove to steer the forceps into the vesical neck. The stone was seized with either straight or curved forceps. If this failed, a dilator was passed and the vesical neck divulsed sufficiently to allow the extraction of the stone. The mortality of this operation was high and the lithotomists were held responsible for their failures. In the case of one mortality, the operator was fined a sum sufficient to lay a stone wall about the village churchyard, a punishment seemingly well fitted to the crime.

The next step was the use of lateral lithotomy in which the incision was made just mesial to the left ischium. The originator and chief exponent of this operation was Frère Jacques, in earlier life a French trooper. He traveled about France in the latter part of the seventeenth century and did not concern himself with postoperative care, stating, "I have extracted the stone, I leave God to cure the patient." Later Cheselden was the most skilful lateral lithotomist and two hundred years ago, operated upon 213 patients with a mortality of 9.3 per cent.

Suprapubic lithotomy was first done in 1556 by Franco but was little used until the latter part of the last century. Its development was retarded by the development of lithotripsy which appeared to be a great advance over a cutting operation without anesthesia.

Crushing calculi by open operation was probably known to Ammonius at about 230 B.C. In 1626 Sanctorius devised a crude instrument for crushing stones without opening the bladder but it was not until the time of Civiale, in the early nineteenth century, that the operation could be performed with reasonable efficiency and safety. Civiale was involved in many arguments as to priority with Leroy d'Etoilles and Heurteloup. His instrument consisted of two metal tubes, the inner tube having three curved projections by which the stone was grasped, and held, while a sharp iron rod was used to bore a hole in it. Several treatments were required to pulver-

* Read before the Section of Genito-Urinary Surgery, New York Academy of Medicine, March 18, 1936.

ize the stone. Weiss invented a curved screw lithotrite in 1824 and Heurteloup designed his curved percussion lithotrite in 1833. It was Bigelow, a Bostonian, who in 1878 employed the modern operation of litholapaxy, in which the calculus is crushed and the fragments evacuated through a metal tube at the same sitting. Since Bigelow's time, little change has occurred in the procedure of litholapaxy except the introduction of the cystoscopic lithotrite, which is preferred by some operators.

The operation of litholapaxy is subject to certain hazards. Among these is the possibility of breaking the instrument when extreme force is applied. Although I have had no personal experience with this accident, I have known of such instances and no doubt some others could cite cases. In this connection it occurred to me that it would be of interest and probably of some practical value to determine by accurate test the limits of strength of a number of lithotrites and in correlation with these tests to measure the exact amount of force required to crush a series of bladder stones of various sizes and compositions. Also, it was thought of value to determine by tests upon a series of artificially constructed spheres of cement and sand, just how the necessary crushing force varies with the diameter of the ball, whether this force varies directly as the diameter, as the square of the diameter or otherwise. The Engineering Department of Columbia University was consulted in this matter and has made possible the practical prosecution of these problems.

Ten vesical calculi have been measured, the amount of force required to crush them determined and the fragments then chemically analyzed. It is desired to continue these measurements until at least twenty-five calculi have been tested, but ten may be sufficient for a preliminary report. Time does not allow me to report all the details of these tests. The calculi were of varied composition, calcium oxalate, calcium phosphate, calcium carbonate, triple phosphate and uric acid. The largest stone was only 4.1 cm. in its greatest dimension. The force required to crush these stones was measured under conditions approximating as closely as possible those prevailing during lithotripsy. Force was applied through two iron bars $\frac{3}{8}''$ wide placed in the same position as the jaws of a lithotrite would be placed. The most resistent calculi were the uric acid ones with calcium oxalate second, the phosphatic calculi being the least resistent. To crush a uric acid stone, applying force through its smallest diameter of 1.6 cm., a pressure of 162 pounds was required. By a ratio which will be indicated later, it can be estimated that a stone of this composition, measuring 5 cm. in its smallest diameter would require more than 500 pounds pressure to crush. Even a stone of this composition 1 inch in diameter would require an amount of pressure greater than the limits of safety of some lithotrites.

In order to determine the limits of crushing power of lithotrites, five instruments were employed, four of the visualizing type and one of the non-visualizing type. The results were as follows:

Instrument No. 1. A lightly constructed visualizing instrument of foreign make with a wheel handle, size 22F. At 140 pounds pressure, the movable jaw began to bend. At 153 pounds pressure, the movable jaw broke at its junction to the shaft.

Instrument No. 2. A visualizing instrument of American make, calibre $19\frac{1}{2}$F. The movable jaw began to bend at 450 pounds pressure and broke at 490 pounds. It was noted that the fixed jaw began to give a little at 350 pounds but after the movable jaw broke, the contour of the fixed jaw returned to its original state. It was found at the end of this experiment that the shaft of the movable jaw could still be moved freely.

Instrument No. 3. Same as No. 2 except that the base of the movable jaw was a little thicker. The movable jaw began to bend at 500 pounds pressure and broke at

550 pounds pressure. Force was then applied to the fixed jaw until it broke near its end at 885 pounds pressure.

Instrument No. 4. Same make as No. 2 and No. 3 but of 22F calibre. In this case the movable jaw began to give at 650 pounds pressure and broke at 712 pounds pressure.

Instrument No. 5. A non-visualizing instrument of English manufacture, calibre 18F. The movable jaw began to give at 650 pounds pressure and broke at 712 pounds pressure. It will be noted that these pressures are the same as in the case of instrument No. 4, a larger instrument of the visualizing type.

In the case of instrument No. 5 I also measured the amount of pressure which I could apply through the screw mechanism and found this to be a maximum of 300 pounds.

In performing these experiments, the instruments were mounted on a large testing machine and equal force was applied to each jaw in opposite directions. The points on the jaw at which the force was applied were selected to approximate as nearly as possible the actual conditions of lithotripsy. In each case the break occurred at the shoulder of the movable blade.

To determine the ratio of the amount of force required to crush a ball having the consistency of a urinary calculus to the diameter of the ball to which the force is applied, twenty spheres of a mixture of sand and cement were constructed, ten averaging 1.35 inches in diameter and the other ten averaging 2.07 inches in diameter. It was found that the amount of pressure required to break the spheres of lesser size averaged 1545 pounds and the pressure required to break the larger spheres averaged 2810 pounds. This experiment is not sufficiently complete to draw any absolute conclusions but it would indicate that the amount of force required to crush a ball of friable consistency, such as a calculus, increases at a little more rapid rate than the diameter. In the experiment just mentioned, the diameter of the larger ball was 1.53 times the diameter of the smaller ball while the pressure required to crush the larger ball was 1.81 times the amount of pressure required to crush the smaller spheres. This ratio is such that if 100 pounds pressure are required to crush a stone one inch in diameter, the amount of pressure required to crush a stone of the same composition 2 inches in diameter would not be precisely 200 pounds but 200 raised to the exponent 1.2 or about 230 pounds. This ratio is quite different from the ratio involved in crushing balls of steel of different diameters due to the fact that in the case of steel the element of ductility is involved so that the pressure required to crush a steel ball varies as the square of the diameter. Without much doubt the precise ratio in calculi varies within narrow limits depending upon the chemical composition of the calculus.

I would like to discuss briefly the treatment of bladder stone in the history of the New York Hospital. The period since 1820, when the first operation for bladder stone was performed at the New York Hospital, has been divided into four sub-periods—1820–1846; 1847–1866; 1866–1920; 1920 to the present date. In the first of these periods there were only 12 operations for bladder stone, 10 of these being perineal lithotomies, one an operation per urethram for stone in the female bladder and one lithotripsy performed in 1846 upon a patient twenty-six years of age. This operation was performed with a duckbill brise-pierre with screw. The procedure had to be repeated nine days later and the patient had a stormy convalescence but was discharged cured after seventy days in the hospital. Of the 10 perineal lithotomies performed, one patient died.

During the early anesthetic era, 1847–1866, there were 35 operations for vesical stone, 27 perineal lithotomies with a mortality of 22.2 per cent, and 8 lithotripsies with 2 deaths, a mortality of 25 per cent.

Between 1866 and 1920 there were 130 cases of bladder stone operated upon, 20 cases of perineal lithotomy with a 25 per cent mortality, 78 cases of suprapubic lithotomy with 7.7 per cent mortality and 32 cases of litholapaxy and lithotripsy, 30 of these cases being litholapaxies, with a 21.9 per cent mortality. Three of these deaths following litholapaxy were proved by postmortem to be due to a ruptured bladder and one other was probably due to this cause. Incidentally it may be mentioned, that the first and second cases of litholapaxy done at the New York Hospital were performed in the year 1878. The first suprapubic lithotomy was done in 1888.

One hundred five cases of vesical calculus operated upon since the foundation of the Brady Department have been studied; 73 were treated by suprapubic lithotomy with a mortality of 4.1 per cent; 32 cases have been treated by litholapaxy with 3 deaths, a mortality of 9.4 per cent. One of these deaths was due to a traumatic rupture of the bladder and peritonitis. A second patient, sixty-one years old, died eight days postoperatively of uremia and the third death in this group occurred three days postoperatively and was due to a pyelonephritis and perivesical phlegmon.

The age distribution of these patients is worthy of note. Previous to 1866, 74.5 per cent of patients with vesical stone were less than thirty years of age whereas since 1920 only 11.4 per cent of the patients have belonged to that age group. It is probable that this decided shift in age incidence is due to improvement in diet among poorer people in the last generation, particularly the more adequate supply of essential vitamins.

As to the relative merits of litholapaxy and suprapubic lithotomy, a few words may be allowed. The choice of operation depends upon the age and physical condition of the patient, the size and hardness of the stone, the presence or absence of urethral stricture or associated prostatic hypertrophy, and the experience of the surgeon. More skill and experience are required to perform litholapaxy properly than to do a suprapubic lithotomy. The advantages of crushing over cutting are two, a shorter convalescence and a lower mortality. The British surgeons in India who have had a large experience with crushing, report a very low mortality, e.g., Anthony in 1926, reported 1532 cases of litholapaxy with a mortality of 0.6 per cent, compared with a usual mortality of 1 to 3 per cent. The mortality of suprapubic lithotomy varies between 3 per cent and 20 per cent and is usually given as 8 to 10 per cent.

The chief contraindications to litholapaxy are as follows:

1. Stones which are quite large or of hard consistency and above a certain size. The hardness of a stone can usually be estimated fairly well before operation by the kind of *x*-ray shadow it casts, a study of the urinary crystals and its cystoscopic appearance;
2. The presence of a large diverticulum of the bladder;
3. Advanced chronic renal pathology;
4. Associated prostatic hypertrophy;
5. A stone formed around a solid foreign body;
6. In markedly contracted bladders, and
7. In badly ulcerated bladders.

I have found the best anesthesia to be caudal. If it is properly administered, it is as efficient as, and less dangerous than, spinal.

Time does not permit a discussion of the details of technique of litholapaxy. A non-visualizing instrument, other things being equal, is of course stronger than a visualizing instrument. Rupture of the bladder should never occur if cases for litholapaxy are properly selected and if proper technique is followed.

In comparing the results, and particularly the mortality, of suprapubic operation and of crushing, it should be considered that the largest and hardest stones are handled by cutting and also that recurrence is more frequent following litholapaxy by reason of fragments left behind. At the

Mayo Clinic there were 7.94 per cent recurrencies in 153 litholapaxies and 4.5 per cent of recurrencies in 295 cutting operations. However, I feel that in this country there are probably too few litholapaxies done. The chief reason for this is that the majority of operators are occasional operators and do not pay sufficient attention to developing a proper technique. Most of us would probably profit by careful study of the procedure as performed by the best of British urologists.

For the occasional operator, suprapubic lithotomy is the safer procedure. For one who has had considerable experience and has developed a proper technique, litholapaxy is the operation of choice in a large number of properly selected cases.

SUMMARY

1. The exact amount of force required to crush calculi of various sizes and compositions has been determined.

2. The extreme limits of crushing strength of 5 lithotrites, 4 visualizing and one non-visualizing, were determined.

3. Some lithotrites are not sufficiently strong to crush very hard calculi of even moderately large size. Other factors being equal, a non-visualizing lithotrite is stronger than the cystoscopic type.

4. It has been established that the amount of pressure required to crush vesical calculic of different sizes varies roughly as the diameter raised to the exponent 1.2.

5. An account of the treatment of bladder stone at the New York Hospital since 1820 has been given.

In closing, I wish to express my appreciation of the kind cooperation extended me by Prof. Finch, Prof. Krefeld and Mr. Kenyon of the Columbia University Engineering Department.

DISCUSSION

DR. SIMON A. BEISLER. Dr. Twinem's work will undoubtedly lead to the production of stronger lithotrites for future use. I have had no experience on the experimental side, and I am sure we have all benefited by his recalling to us the different things which arise by reviewing the literature, namely the vast number of younger people prior to the twentieth century, not only in this country, but more strikingly in India, having bladder stones, due undoubtedly to vitamine A deficiency, as was so well proved by Higgins in his experimental work.

DR. PAUL A. BUTTERFIELD. Dr. Twinem has done a service to us in calling attention to an old method of treating bladder stones which we have more or less forgotten because we are not sufficiently expert in using the instruments in the proper way. I think there is a large percentage of cases of bladder stone without infection or obstruction which should be treated in that way.

DR. ABRAHAM HYMAN. We are all indebted to Dr. Twinem for his experimental work in demonstrating the tensile strength of instruments and the difficulty which we may encounter in crushing some stones. I have had no experience with this type of experimental work, but I can see where it will be of great value to our instrument makers. Lithotripsy in this country is a considerably neglected procedure. For many years the younger group of urologists, not having been trained in this method, have neglected to use it and have resorted to suprapubic cystotomy. As a result many patients have been subjected to a needless operation with its consequent long hospitalization. The reason that litholapaxy in this country is seldom practiced is due to the fact that there is no school of litholapaxy as there is abroad. Many years ago I was greatly impressed by the remarkable skill of the Continental surgeons who practiced litholapaxy. I remember seeing Freyer, Zuckerkandl and other expert lithotriptists, and it seemed to me as if they really had their eye in the end of the lithotrite. They would take a large stone and crush it in five or ten minutes and at the first evacuation remove all the fragments so that it was not necessary to reintroduce the instrument. That impressed me and I determined to make a study of this procedure. Since the advent of the visual lithotrites in this country I think more men have been resorting to litholapaxy in the treatment of vesical calculi. Having been educated in the old school, I prefer the non-visualizing instrument as I think they are much stronger, and to one who has been reared on this method it is not necessary to see what you are doing.

Regarding the contraindications for litholapaxy that were mentioned by Dr. Twinem,

there is one point in which I disagree and that is the size of the stone. I do not think the size of the stone is really any contraindication to litholapaxy providing you are dealing with a bladder which can be readily distended and in which there is not sufficient enlargement of the prostate or any obstructive condition of the neck of the bladder to interfere with free movement of the instrument, and in proof of that I should like to show the *x*-rays of a few very large stones which have been crushed. This type of large stone can be readily grasped with the non-visualizing lithotrite, and I have seen stones even larger ones crushed with the lithotrite.

The further contraindications to litholapaxy are contracted bladders, advanced renal disease, marked cystitis, stones in diverticula and large prostates. We have developed a procedure in litholapaxy which I think is of some value because it eliminates a great deal of instrumentation. When the ordinary litholapaxy is done, using the non-visualizing lithotrite, the lithotrite is introduced, the stone is crushed, and another sheath is inserted into the bladder to evacuate the fragments. If there is any doubt, the cystoscope is introduced to see how much is left. If there is residual stone the lithotrite is again introduced, and sometimes that performance has to be repeated a number of times, necessitating a good deal of instrumentation. The lithotrite is introduced and the calculus is crushed until there are no further fragments to be picked up by the lithotrite. Instead of the evacuating sheath we introduce an ordinary cystoscope and this attachment. I do not know who is responsible for it, but I came across it five years ago. It was published in one of the journals, and is a very clever arrangement. One end fits into the bulb, and the other into the cystoscope, through which the fragments are evacuated. An observation cystoscopy dispenses with the introduction of numerous instruments.

In analyzing our last 100 consecutive cases of litholapaxy we had one death. This was a patient who should not have had a litholapaxy; the bladder was contracted; there was a cystitis, and as a result the patient developed a pyelonephritis and died from uremia.

I have never had a lithotrite break in the bladder, but I have seen it happen, necessitating an immediate opening of the bladder to fish out the broken fragment.

A word about the diagnosis of vesical calculi by *x*-ray findings. In going over a series of 57 cases of vesical calculi, in 35 instances we found that no shadow was thrown by the stone. In 61 per cent of the cases the stones failed to be visualized in the *x*-ray picture, so we must never rely on a negative *x*-ray film. Since a large number of stones form as a result of obstruction at the vesical outlet caused by prostatic enlargement, it is important to remove this prostatic obstruction, as otherwise the calculi will reform. I have seen calculi, in the face of prostatic obstruction, reform within a period of six months. Since the advent of prostatic resections our ideas have changed somewhat as to the treatment of vesical calculi, complicated by prostatic hypertrophy. Up to a few years ago most men felt that in the face of prostatic enlargement, especially of the median lobe, it was preferable to do a suprapubic cystotomy, remove the calculus and later do a prostatectomy. We never thought it advisable to do a one stage operation, that is, a cystotomy with extraction of the stone and a prostatectomy at the same time, because these cases did not do well. Most of them had a cystitis and subsequently developed an upper urinary tract infection, so that in the majority of patients the combination of stone and prostatic enlargement meant a long hospitalization. Recently views have changed and now it is feasible to do a litholapaxy and a resection, sometimes in one stage, but it is preferable to do it in two stages, and in this way save the patient a long period in the hospital. At the Mayo Clinic they recently reported a series of 55 cases in which procedure was done in one stage. I have tried it in a few cases lately and it has worked very well. In most of the cases it is advisable to do the litholapaxy first and then the resection. If the enlargement of the middle lobe interferes with the litholapaxy, the procedure is to do a resection first and then the litholapaxy.

DR. RUSSELL S. FERGUSON. Litholapaxy interested me in that Dr. Twinem's report stated that at the New York Hospital, when there was no urological department and general surgeons operated on vesical calculi by cystotomy, their mortality was less than that of the urologist who crushes the stone. The Mayo Clinic figures, with general surgeons operating on open cases, showed the same thing. I am sure our resident now at New York Hospital has a better

record on cystotomy for stone than has Dr. Keyes in his records for litholapaxy, and Dr. Keyes is an accomplished operator but he has no enthusiasm for the procedure at present, except for small stones. I think the clean open operation is much to be preferred, and personally I think the lithotrites at present available are strong enough for as large a stone as should be crushed.

DR. JOHN A. TAYLOR. I would like to cite one technical difficulty I have always experienced with the Bigelow lithotrite in that it becomes clogged with the crushed material so that the blades get stuck, and one has to take it out, clean it and then reinsert it. I think it might be advantageous to do a little experimental work along that line to get some sort of an open blade which would not allow the gravel to pack up.

DR. MEREDITH F. CAMPBELL. I would like to ask Dr. Twinem if his experimental work was done on dry stones or wet stones. Wet stones are notoriously softer and crush easier.

DR. FRANCIS PATTON TWINEM (closing). I have only a word to say in answer to Dr. Campbell's question. The point that Dr. Campbell raised was considered, and the stones were handled in this way. As soon as the stone was removed, or almost as soon as it was removed, it was placed in a bottle of either urine or water, and kept in that way until the time the test was made. It was assumed, correctly or incorrectly, and I think it is probable, that the consistency of a stone kept in that way for a few days before crushing is very close to what it is when it is lying in the bladder.

A word about the use of visualizing and non-visualizing instruments. I think that the non-visualizing instrument should be used more, and if the proper technique is followed, and we should all study the proper technique and observe men who are very skilled in this line, I believe that more of us would use the non-visualizing instruments. Dr. Joly comments on this point and states that a cystoscopic lithotrite has never been made in England. This statement was made three years ago and I think none has been made since, and Joly said he hoped none ever would be made. That is his attitude on the subject.

I do not believe you can assume any lithotrite we have will be strong enough to crush any stone which can be included within the jaws, because one instrument broke at 155 pounds. A hard uric acid stone, 1 cm. in diameter, which I think almost anyone will admit ordinarily is considered small enough to be crushed by lithotripsy, would be likely to require 200 pounds pressure to crush it. If you don't choose and use your lithotrite with care you are going to get into trouble with some particular stone, and while that will not happen very often, one or two cases in a lifetime are enough.

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* *Continued from p. 33.*

NEPHROPTOSIS*

A REVIEW OF THE LITERATURE AND AN ANALYSIS OF PALLIATIVE OR OPERATIVE TREATMENT IN 266 CASES OF PRIMARY NEPHROPTOSIS

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THE purpose of this paper is to ascertain the effectiveness of the various treatments of nephroptosis and particularly by means of nephropexy.

DEFINITION

Bearing in mind that the normal kidney moves from 2 to 5 cm. on respiration, that the lower pole of the right kidney is usually palpable on deep respiration in a thin person, and that pyelography normally shows a movement of from 10 to 12 mm., the term *movable kidney* is here used to describe a kidney whose mobility is abnormal, in contradistinction to a true *floating kidney*, which is one that rises or floats on a true mesentery to the anterior abdominal wall. The latter is exceedingly rare, there being only a few authentic cases recorded.

LITERATURE

The earliest reference to the subject of nephroptosis is that of Meuse of Venice, published in 1495. Fuller recognition came with the publication of a single case by Pedemontanus in 1581. Exactly a century later, 1681, Rilan stated his belief that urinary stones and tumors were causative factors. For many years nothing further was published upon the subject. In 1841 Rayer produced his epochal classic, and in 1859, Dietl, of Vienna, described the condition since known by his name, Dietl's crisis. Hare, in 1860, advocated the use of elastic abdominal belts to support the kidney. In 1878 Martin cured 2 cases by performing nephrectomy.

The first suspension was done by Hahn of Berlin in 1881. The following year Weir performed the first such operation in The New York Hospital; this, so far as we have been able to ascertain, was the first nephropexy done in America. There soon followed a period of over-enthusiasm, when many unnecessary nephropexies were done and the practice of suspending the kidney achieved the proportions of a popular fad. Then about 1900 came a period of doubt. At this time Israel and Tuffier contended that nephroptosis was simply a part of a generalized visceroptosis.

Mobility of the right kidney is present in 22 per cent of women, according to Edebohls and Glenard; in 2 per cent of men, according to Goelet and Han, and Southam records that mobility of the ascending colon and cecum occurs in 20 per cent of all people. H. L. Morris states that at the level of the first lumbar vertebra the right kidney fossa is 2 cm. broader than on the left side and that the right kidney fossa is 1 cm. deeper than the left. P. G. Smith contends that the highest fixed point of the ureter is where it is attached to the anterior layer of the perirenal fascia, that is, at a point level with the lower pole of the kidney. Mathe states that the highest fixed point of the ureter is 1 cm. above where it crosses the spermatic or ovarian vessels, namely, where the ureter leaves the peritoneum. Sir James MacKenzie, according to J. J. Bell, has shown that most symptoms are disturbances of normal reflexes. A movable kidney tugging on its pedicle, he believes, produces reflex disturbances. Bell also states that at operation the adrenal can be seen to be pulled down; its circulation, he contends, is therefore disturbed by the stretching of the vessels. Lowsley states that a pathologic condition, existing prior to an accident but without producing symptoms, may be greatly aggravated by a trauma, so that a person may honestly believe his injury to be the primary cause of his condition. Billington did 524 nephropexies including 179 double pexies, on 345 patients with a mortality of less than 1 per cent and never failed to anchor the kidney.

* From the James Buchannan Brady Foundation of Urology, New York Hospital, Cornell Medical Center, New York City. Presented at the New York Academy of Medicine before the Section of Urology, February, 19, 1936.

THE NUMBER OF CASES REVIEWED

This paper is based upon an analysis of 266 cases of primary nephroptosis treated in The New York Hospital during the last twenty years, i.e., from 1914 up to the present. In 59 of these nephropexy was done; 46 on the right side, 8 on the left side (in one of these nephropexy was done twice on the same side on the same patient), and 6 were bilateral, making a total of 67 nephropexies in the New York Hospital during the last two decades. These 266 cases are divided as follows:

The total number of cases of primary nephroptosis treated in the Brady Foundation is 179; 38 had nephropexies, 28 being on the right side, 6 bilateral and 4 on the left side, or a total of 44 operations.

The total number of cases of primary nephroptosis, excluding the Brady Foundation, is 87. In 21 of these nephropexy was done, 18 being on the right side and 4 on the left, including the case in which nephropexy was repeated in the same patient, making a total of 23 operations.

In addition, there were recorded 128 cases of secondary nephroptosis; that is, nephroptosis discovered during examination for other primary conditions. Inasmuch as these were not treated, they have not been included in this analysis.

HISTORY

In our series of 266 cases the family history was negative in 82 per cent, and in the 18 per cent in which it was positive the record was irrelevant.

The personal history revealed one or more of the various exanthemata in childhood in 38 per cent, appendectomy in 21 per cent, and bilateral epididymitis in 2 per cent, a point which, in the author's opinion, should be noted. There was a history of ventral suspension for excessive bleeding in 3 per cent, perinephritic abscess in 1 per cent, left nephrectomy in 4 per cent, (in one the nephrectomy had been preceded by nephrotomy and nephropexy), right nephropexy in 3 per cent (in one case followed by extirpation of the kidney), removal of the right tube and ovary in 3 per cent and bilateral decapsulation of the kidney in 1 per cent. One per cent had chronic cholecystitis, 4 per cent acute tonsillitis and 14 per cent had had their tonsils and adenoids removed.

SYMPTOMS

The cardinal symptom in movable kidney is pain, due either to (1) increased intracapsular tension or (2) torsion or pull on the renal pedicle. This symptom was present in 100 per cent of the cases: 33 per cent had severe colic, 50 per cent moderate pain and 17 per cent complained only of a dull ache.

Referred pain was exhibited in the following regions: knee, rectum and perineum, 1 per cent each; vagina and testis, 2 per cent each and epigastrium 3 per cent.

The chief bladder symptoms were frequency 33 per cent; urgency 25 per cent; dysuria 25 per cent and terminal hematuria 15 per cent. Nocturia was present in 10 per cent of the cases.

Nausea and vomiting were present in 9 per cent of the cases.

General toxemia of greater or less degree was a common finding, but only 7 per cent had chills and fever and 5 per cent had fever alone.

General nervous excitability was present in most of the cases. Two per cent complained of dizzy spells, 1 per cent of hyperesthesia, 3 per cent of insomnia, 3 per cent of emotional disturbances and 1 per cent had psychosis.

EXAMINATION OF URINE

Urinalysis is of but slight value in making the diagnosis. Albumin, however, is practically always present. A study of the urinary findings in 90 cases reveals that a trace of albumin was present in 75 per cent, casts in 1 per cent, acetone in 2 per cent, oxylate crystals in 2 per cent, blood in 50 per cent and pus in 75 per cent.

PHYSICAL EXAMINATION

Examination of the head, neck and chest disclosed positive findings in only 7 per cent of the cases. These included a systolic murmur at the apex and base, a suggestion

of mitral murmur, simple tachycardia, a slightly enlarged thyroid, stupor (1 case each) and 2 cases of enlarged tonsils.

Forty-five per cent of the patients had good teeth and 55 per cent bad.

The genitals were negative in 93 per cent of the cases. Positive findings were congestion of the prostate and left epididymis, 2 cases each; left varicocele 1 case and retroversion, 2 cases.

No abnormal reflexes were noted.

Examination of the abdomen revealed ptosed and palpable kidneys in 48 per cent of the cases (33 per cent were on the right side and 15 per cent on the left). Pain and tenderness were present in 58 per cent (33 per cent on the right side and 25 per cent on the left).

ANALYSIS OF THE *X*-RAY FINDINGS

Side	Size of Kidney			Position			Ureter			Pelvis			Calyces	
	Small, Per Cent	Normal, Per Cent	Large, Per Cent	Normal, Per Cent	Low, Per Cent	Very Low, Per Cent	Kink, Per Cent	Normal, Per Cent	Stricture, Per Cent	Normal, Per Cent	Dilated, Per Cent	Large, Per Cent	Dilated, Per Cent	Shaggy, Per Cent
Right*	9	68	21	0	82	16	68	9	23	35	0	65	60	54
Left	5	75	22	21	73	6	70	2	28	44	0	56	50	32

* Right kidney absent in 2 per cent.

FUNCTION OF THE KIDNEYS

In 58 per cent of the cases the function was less on the side containing the lower kidney; in 33 per cent the function was equal on both sides (i.e., on the high kidney side and on the low kidney side); and in 9 per cent the function was greater on the side on which the kidney was lower.

ANALYSIS OF THE X-RAY REPORTS

The radiographic findings are summarized in the accompanying table.

TREATMENT

Three forms of treatment are available: (1) prophylactic, (2) palliative, and (3) operative.

Prophylactic measures include keeping well nourished and avoidance of trauma and such postures and occupations as tend to produce ptosis.

Palliative treatment, to be supplemented by prophylactic measures, consists of rest in bed, with the foot of the bed elevated 12 inches, forced feeding and the wearing of a belt to support the kidney.

Operative treatment should aim at securing the kidney in a position sufficiently high to prevent kinking of the ureter, thereby assuring proper drainage.

The technique employed at the Brady Foundation is as follows: Through the usual incision the kidney is exposed and freed of all adhesions. The ureter is then similarly freed down to its normal fixed point, and farther if necessary, so that it may be pulled into a position sufficiently high to remove all kinks. Ribbon gut is passed through four loops in the fibrous capsule of the kidney (one on either side of the upper and lower poles), and the ends tied so as to form a sling or basket. The ends of the ribbon gut are then passed around the twelfth rib and again tied; this anchors the kidney securely in position.

POSTOPERATIVE TREATMENT

The patient should remain in bed for a minimum of three weeks, with the foot of the bed elevated 12 inches. Except in comparatively rare cases of left sided operation, he should lie on the right side. During the first week he should remain in the recumbent position and during the first two weeks should not lie on the unaffected side. By the end of the third week he may sit up in bed and by the end of the fourth week he should be up and about.

The entire period of convalescence occupies about six months, during which time the patient will usually complain of vague pains.

A properly fitting belt should be worn for some time after the operation.

RESULTS

In a follow-up of 15 cases of the 38 operated cases 11 were cured and 3 improved. However, the result of the operation in these 3 cases was anatomically correct in that pyelography revealed that the kidney which had been operated was in good position. One patient that had been operated had tuberculosis of the kidney.

SUMMARY OF THE FINDINGS

Anatomy. The chief factors here are:

(a) That the perirenal fascial compartment is open mesially below the hilum, i.e., the anterior and posterior layers do not fuse below this level; but there is no communication with the opposite side.

(b) This perirenal fascial compartment is wide open below the kidney and is far too large for the kidney which it contains.

Etiology. The latter anatomic fact is the chief factor in the causation of ptosis of the kidney.

Family History. This was negative in 82 per cent of the cases.

Personal History. Thirty-eight per cent had exanthemata in childhood, 21 per cent had appendectomy and 14 per cent had removal of the tonsils and adenoids.

Symptoms. Pain was present in 100 per cent of the cases and urinary frequency in 33 per cent.

Physical Examination. Ninety-three per cent were negative in regard to the lower urinary tract.

Urinalysis. Pus and albumin were found in 75 per cent of the cases.

Kidney. The kidney was found enlarged in 21 per cent of the right sided cases, low in position in 82 per cent and very low in 16 per cent. On the left side, there was enlargement of the kidney in 22 per cent, in 73 per cent the organ was low and in 6 per cent very low.

Ureter. Sixty-eight per cent of the right sided cases had kinking of the ureter and 23 per cent stricture; on the left side 70 per cent had kink and 28 per cent stricture.

Pelvis. The pelvis was enlarged in 65 per cent of the right sided cases and in 56 per cent of those involving the left side.

Calyces. Dilatation of the calyces was present in 60 per cent of the right sided cases and shagginess of the calyces in 54 per cent. On the left side 50 per cent had dilated calyces and 32 per cent shagginess.

Function. The function was less on the side containing the low kidney in 58 per cent of the cases.

Chief Indications for Operation. These are (a) pain, due to ptosis and (b) inadequate drainage.

Incidence of Ptosis. Altogether, there were 394 cases of nephroptosis; 266 of these were primary diagnoses and the remainder secondary diagnoses. A total of 67 nephropexies were done in the 59 operated cases.

Results. An attempt was made to communicate with the 38 cases operated in the Brady Foundation. Of the 15 who responded 11 were cured, 2 had perfect anatomic results, 1 had no colic but still complained of pain and 1 had tuberculosis of the operated kidney. An attempt was also made to get in touch with 141 patients who had been given belts, et cetera; only 12 of these responded, about one-third of whom were entirely improved and one-third improved with dilatation of the ureters. The rest were not improved and one of these refused operation even though she had severe colic.

CONCLUSIONS

From a consideration of the literature, and from the results of this investigation, we conclude as follows:

1. The colon may have its normal peritoneal supports so disturbed as to cause sagging with consequent impairment of its circulation, etc., resulting in severe constipation.

2. The spleen may move with the left kidney and have interference with its circulation.

3. A ptosed kidney may cause such pressure on the pelvic organs as to produce symptoms referable to them.

4. A possible explanation of gall-bladder stasis is that the nephroptosis causes a kinking of the cystic duct, resulting in gall-bladder disease.

5. *Fibrous Adhesions.* These form between the renal capsules and the perirenal fascia. This takes place as renal mobility is increased from one cause or another, and is Nature's method of cure. If the kidney continues to move downward, the perirenal fascia, though firmly fixed, becomes loosened and travels downward, too, thus altering the position of those organs in intimate contact with its anterior layer and producing symptoms referable to the gastrointestinal tract.

6. The renal pelvis may readily empty itself although there is an abnormal amount of mobility with resulting tortuosity of the ureter; on the other hand, it may not empty in some cases showing only slight mobility. This may result in stasis if there is fixation of the upper ureter.

7. The emptying time of the renal pelvis is estimated by injecting the opaque medium into the kidney pelvis, removing the catheter, and taking *x*-ray pictures every five to ten minutes until the pelvis and ureter are emptied, providing, of course, that they will empty completely. The normal emptying time is from five to ten minutes.

8. Intravenous pyelography should be used in cases not suited to the foregoing method of examination.

9. It is possible to injure, crush or suddenly displace by violence a normally fixed kidney, but such displacement is always accompanied by laceration of the perirenal tissues, manifested by distinct local and general symptoms. Movable kidney, therefore, seldom or never follows severe injuries involving the kidney or perirenal tissues.

10. Kinks, fixed by adhesions, may readily form in persons who have had to stand for long periods without being able to change their positions; these will lead to severe hydronephrosis, which, in turn, will be a factor in ptosis.

11. It should be noted that the viscera are held in place chiefly by the abdominal and pelvic muscles and that they are not held in suspension by the peritoneum but only in proper relationship. The ptosed kidney does not draw the peritoneum with it.

12. The operation of nephropexy, properly performed, is the cure for nephroptosis in those cases where operation is indicated.

DISCUSSION

DR. CLARENCE BANDLER. Dr. Church has presented a complete and detailed review of a long series of cases of nephroptosis, many of which were successfully operated at New York Hospital. I am quite in accord with the views expressed by Woodruff and Scherer as well as those of Birdsall so well detailed in their papers read at the last meeting of the American Urological Association in San Francisco. Our experience over a period of years confirms the opinion that all patients having symptoms definitely related to alteration in renal position should be given the advantage of operative procedures to place the kidney so that there shall be no excessive relaxation of the ureter at its pelvic junction. A properly performed nephropexy will accomplish this purpose. Change of renal axis is just as important as fixation of the kidney. I do not believe that it makes a great deal of difference, in performing nephropexy, whether one fixes the kidney by means of properly placed mattress sutures of chromic gut with fat transplants interposed or by use of ribbon catgut as a sling for fixation. My experience has been with the chromic gut technique and I can see no especial objections to this almost standardized procedure. As I see the problem, the important consideration is to operate on those patients whose symptoms will surely be relieved by adequate surgery and not to operate solely for the purpose of correcting excessive renal mobility. It is a well known fact that a quarter of a century ago, under the influence of many general and urologic surgeons, all patients in whom movable kidneys could be demonstrated were subjected to nephropexy. Then followed a period of time in which this operation was discredited and patients with definite symptoms due to nephroptosis were surgically neglected. In recent years, how-

ever, urologists have taken a more rational stand and now those patients properly operable are being cured by surgery and others are getting relief from ureteral dilatation and similar conservative procedures.

DR. GEORGE HOCH. To do a nephropexy on all palpable kidneys or a repair of the ureteropelvic junction of the ureter in all cases of dilatation of the renal pelvis seems ill advised and a word of caution should be expressed lest we go too far afield and become too radical.

A proper interpretation of suitable cases for nephropexy requires a careful history, physical and urological study. Mobility is usually put in three degrees and each may be with or without symptoms. Then, too, these symptoms have to be put in their proper relationship. It is an understood fact that gastric and intestinal symptoms are not infrequent accompaniments of renal disease. The symptom complex that is easy to interpret is pain, obstruction, infection, gastric symptoms, nervous symptoms. When, however, the latter two come first the case requires considerable study before we can place the kidney as the primary disease.

Infection in many of these cases obscures our judgment. With obvious stasis there is no doubt as to operation, but in the absence of stasis curing the infection causes relief of all symptoms.

DR. H. DAWSON FURNISS. A number of us saw the abuse of nephropexy which occurred many years ago and I think its abuse made many of us lean backward in not giving patients the benefit of it, so I think this report is most timely. Dr. Hoch brought out that a great many of these patients who are suffering from digestive disturbances are relieved by nephropexy; this corresponds with my experience.

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MERCRESIN, A NEW SURGICAL GERMICIDE*

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THE problem of wound infection is a constant one to all who are interested in the practice of surgery. The weak spot in the many procedures aimed at preventing the entrance of bacteria into a clean operating wound is the presence of organisms in and on the skin itself. Other factors, such as undue traumatizing of tissues, unsterile catgut and breaks in the operative technique may also be the cause of the small percentage of wound infections that continue to occur in so-called clean cases.

The preparation of the operative field has properly received considerable attention and a number of germicides are in use. Although many laboratory tests have been proposed, the bacteriological study and evaluation of these germicides has been standardized by the United States Government.[1] The clinical evaluation of such products, however, is more difficult and obviously cannot be controlled so readily as in vitro experiments. The factors of individual resistance, immunity, possible differences in the kind and virulence of contaminating organisms, variations in the type and extent of operations, and skill of the surgeon so add to the complexity of the problem that definite conclusions as to the relative merits of one germicide over another are often difficult. In full realization of these obstacles, we have undertaken to evaluate "mercresin," a new germicide recently brought to our attention.

Mercresin is a unique type of germicide in that it contains an organic mercurial, ortho-hydroxyphenylmercuric chloride (mercarbolide), and a synthetic cresol derivative† (pentacresol). There are excellent reasons for this combination. Despite the wide acceptance and use of many mercurial antiseptics today, it has been repeatedly shown and is now recognized, that what have appeared to be highly germicidal properties have been due in reality to the powerful bacteriostatic action inherent in all organic mercurials.[2–5] This appears to be particularly true of the action of the mercurials on certain organisms, one of which, Staphylococcus aureus, is a standard used in the official tests for germicidal solutions. Although ortho-hydroxyphenylmercuric chloride has been shown to have greater germicidal potency against standard organisms than other mercurials in common use,[6] the failure of the mercurials as a group to be quickly bactericidal against Staphyloccocus aureus led to the addition in mercresin of the synthetic cresol derivative, which has a high degree of the desired bactericidal action.[6] An important finding was that when the synthetic cresol was added to the ortho-hydroxyphenylmercuric chloride, it did not merely supplement the action of the latter on Staphylococcus aureus, but resulted in a synergistic action which made the combination, mercresin, from 200 to 300 per cent more germicidal than the sum of the two components alone.[6]

Mercresin tincture contains one part each of ortho-hydroxyphenylmercuric chloride and the synthetic cresol derivative in 1000 parts of a solution containing 50 per cent alcohol and 10 per cent acetone. The alcohol and acetone favor penetration by dissolving the fatty materials and epithelial debris always found on skin surfaces, and also shorten the time required for drying. Added to this solution, for the purpose of defining the area of application, is a small amount of water-soluble coloring material, orange G, which is easily removed from the skin and hospital linens with soap and water. Mercresin tincture has been shown to have sufficient germicidal power to be effective in dilutions up to 1 to 20, a point where the alcohol and acetone is non-irritating. It is compatible with both acids and alkalis, does not react with the chlorides of body fluids, does not precipi-

† A mixture of 5 isomeric amyl cresols derived from the interaction of amyl alcohol and cresol, U.S.P.

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tate serum proteins, and is miscible with water in all proportions.

Mercresin has a toxicity of the same order as that of other well known organic mercurial germicides. This statement is based on the results of extensive studies of the oral, intramuscular, intravenous and intraperitoneal toxicity of mercresin in rats compared with other organic mercurial germicides.

The following data on the bacteriostatic and bactericidal potency of mercresin are based on investigations by Dunn, of the Department of Bacteriology of Massachusetts Institute of Technology[6] and by the Department of Bacteriology, Iowa State College.[7] Table I[6] shows the germicidal power of mercresin compared with other commercial products, using the official F.D.A. method at 37°C. with Staphylococcus aureus. The negative signs in the column headed "Culture" indicate a failure of growth. This might be due either to a bacteriostatic or a germicidal effect. The occurrence of growth in the subculture, as shown by a positive sign in that column, indicates that the failure of growth for the corresponding time period in the "Culture" column was due to a bacteriostatic effect and not to the death of the organisms. Only hexylresorcinol and mercresin were lethal at all time periods.

TABLE I

GERMICIDAL POWER OF VARIOUS ANTISEPTICS TOWARD STAPHYLOCOCCUS AUREUS

Product	Dilution of Commercial Product	Dilution of Active Ingredients	Culture, Minutes			Subculture, Minutes		
			5	10	15	5	10	15
Mercurochrome (2 per cent tincture)	1–3	1–150	+	–	–	+	+	+
Merthiolate (1–1000 tincture)	1–3	1–3,000	–	–	–	+	+	+
Metaphen (1–200 tincture)	1–5	1–1,000	–	–	–	+	+	–
Phenyl mercuric nitrate. P.M.N. (1–1250 aqueous)	1–1	1–1,250	–	–	–	+	+	+
Mercurophen	....	1–1,000	–	–	–	+	+	+
Mercuric chloride	....	1–200	–	–	–	+	+	+
Hexylresorcinol (1–1000 aqueous)	1–5	1–5,000	–	–	–	–	–	–
Mercresin tincture	1–20	1–10,000*	–	–	–	–	–	–

* This represents a 1–20,000 dilution of each of the active ingredients.

Table II[7] shows the data comparing the bacteriostatic or growth-inhibiting power of mercresin with several other commercial products. Results are expressed in dilutions of equal concentration (1–1000). For example, mercresin 1–3200 means 1 volume of mercresin diluted to 3200 parts of water. The superiority of mercresin is apparent.

TABLE II

BACTERIOSTATIC ACTION IN F.D.A. BROTH AND SERUM BROTH USING STAPHYLOCOCCUS AUREUS AT 37°C.

Product	Highest Dilutions Which Are Bacteriostatic	
	F.D.A. Broth	Serum Broth
Mercurochrome tincture	1–40	1–20
Merthiolate tincture	1–800	1–400
Metaphen tincture	1–300	1–80
Hexylresorcinol	1–20	1–10 (fails)
Mercresin tincture	1–3200	1–800

The importance of testing germicides against a variety of bacteria rather than limiting the examination to the commonly used test organisms has been emphasized repeatedly.[8–11] Table III[6] shows the dilutions of mercresin which are lethal to a variety of organisms in five minutes.

TABLE III

MAXIMUM DILUTIONS OF MERCRESIN TINCTURE WHICH WERE LETHAL TO VARIOUS ORGANISMS IN 5 MINUTES

Dilutions of Mercresin Tincture	Organisms
1–20	Staphylococcus aureus
1–10	*Escherichia coli (B. coli)
1–30	Pseudomonas aeruginosa (B. pyocyaneus)
1–25	Serratia pyoseptica (similar to B. prodigiosus)
1–30	Eberthella typhosa (B. typhosus)
1–20	Corynebacterium pseudodiphtherium (B. Hofmanni)
1–25	Streptococcus hemolyticus
1–20	Corynebacterium diphtheriae (B. diphtheriae)
1–40	Tricophyton interdigitale (ringworm)
1–120	Actinomyces
1–20	Blastomyces

* 10 minutes.

Since in preoperative use the interval of time between the application of the antiseptic and the start of the operation is brief, it is important to know the rapidity of the germicidal action of mercresin. This

is given in Table IV.[6] A dilution of 1–10 killed Staphylococcus aureus in a minute, and in less time with greater concentrations.

TABLE IV
THE RAPIDITY OF THE GERMICIDAL ACTION OF MERCRESIN AGAINST STAPHYLOCOCCUS AUREUS BY A MODIFIED F.D.A. PROCEDURE

Dilutions of Mercresin Tincture	Killed Staphylococcus Aureus in
1–6	11 seconds
1–8	30 seconds
1–10	1 minute
1–12	4 minutes
1–20	5 minutes

Table V[6] shows the results obtained with the serum cup-plate test using Staphylococcus aureus at 37°C. This represents the usual laboratory method of demonstrating the penetrability of germicidal solutions. The zone of no growth was wider for mercresin than for any of the other germicides tested.

TABLE V
PENETRABILITY OF VARIOUS GERMICIDES WITH SERUM CUP-PLATE TEST USING STAPHOLOCOCCUS AUREUS AT 37°C.

Product	Concentration of Active Ingredients	Average Diameter in Mm. of Zone of No-growth
Tincture of iodine.	1–16	18.0
Hexylresorcinol...	1–1000	6.0
Merthiolate.....	1–1000	11.5
Metaphen.....	1–200	11.0
Mercresin tincture	1–1000	23.0

With such conclusive evidence in favor of this new preparation, it seemed worth while to permit a trial of tincture mercresin as a preoperative skin antiseptic in the University Hospital. The results proved so gratifying in 1200 cases that it has been adopted as the routine antiseptic for all general surgical cases. The percentage of wound infections has remained consistently low. The stain following its application disappears spontaneously within three to four days or can be readily removed by washing the skin with alcohol or water. The non-irritating properties of the antiseptic have been apparent. In only one instance has there been any reaction in the skin following its use, this taking the form of a fine vesicular eruption superimposed upon a diffuse erythema. This dermatitis disappeared within four days, leaving no residual changes in the skin.

An evaluation of further uses of mercresin is being continued and will be reported later. Dilutions of mercresin of 1–15 are being found effective in various urological treatments.

SUMMARY

The characteristics of mercresin tincture which make this solution a powerful antiseptic have been presented. Its advantages are as follows:

1. High germicidal and bacteriostatic properties.
2. Rapid action.
3. Satisfactory penetrability.
4. Sufficient color to define the extent of the field prepared as well as the ability to lose this color rapidly.
5. The ability to dissolve fat and degenerative cellular debris from the skin surface.

Furthermore, its use in a large series of surgical cases has proved it to be non-irritating and has demonstrated its efficacy as a preoperative skin disinfectant.

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TREATMENT OF ACUTE EMPYEMA*

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THE discussion of some high lights in the development of the treatment of empyema is offered with a desire to focus attention on the efficiency of an operation for its cure. There is no reference to tuberculous infection or those empyemas that are the result of trauma, chronic lung abscess or adjacent suppurations. The chief interest is with the common group of uncomplicated empyemas following respiratory infection.

The earliest direct reference of the treatment of acute empyema comes from Hippocrates,[1] who gave an account of its symptoms, treatment and prognosis; it is interesting to note that he advised thoractomy with knife or cautery, daily dressing and the injection of wine and oil. He likewise mentioned that the patient usually recovers in forty days or passes into phthisis. Hedblom[2] quotes that Auenbrugger[2] in 1761 brought forth the art of percussion, stimulating earlier diagnosis in thoracic suppuration. In 1810 Aupepin described a technique of thoracotomy, making the skin and intercostal incisions at different levels for a valve effect to prevent pneumothorax. While Galen mentioned rib resection for osteomyelitis in empyema, Roser[3] proposed it as a cure for empyema in 1865. Billroth, Keonig and Ewald all followed his suggestions practically simultaneously. Hewitt, in 1876, advised continuous drainage by tube. In 1890 Forlanini advocated the aspiration of pus and its replacement with air. In 1891 Bulau suggested inter-rib puncture with siphon drainage and rib resection. In 1898 Perthes added a suction pump to the drainage. In 1900 rib resection with open drainage was routine, and the mortality generally about 30 per cent. At the eighth German Congress of Medicine in 1903 aspiration and irrigation were rejected and the controversy was between the procedures of inter-rib puncture with siphon drainage and rib resection. In 1911 Tigel advocated a metal drainage tube with valves to go through the rib; others advocated rubber tubes with valves. In the same year Kenyon[4] introduced the method of closed drainage by way of interrib puncture with the tubing leading into a water bottle. Wilson introduced an empyema button with flanges to maintain adequate drainage; this was an open method.

BACTERIOLOGY

The organisms found in empyema are the same found in suppurations elsewhere; however, the majority of cases are caused by the pneumococci and streptococci.

The Streptococcus hemolyticus is generally the offender in most of the complicated and overwhelming infections. There is a greater diversity in the pathologic picture in the streptococcic empyemas due to the more frequent variation in the virulence of these bacteria. The pleural inflammation due to the pneumococcus usually comes late in the course of pneumonia and contains a highly fibrinous, thick, yellow pus, while in the case of the streptococcus, at times there may be a marked exudate within a few hours after onset, the pleural involvement obscuring the underlying pneumonia. In the early stage streptococcus pus is usually thin, watery, greenish or brownish, containing little fibrin, often having a sweet or sickening odor. In days or weeks the pus becomes thickened, but in the early stages it is not fibrinous enough to fix the mediastinum.

* Thesis submitted in partial fulfillment of work done toward degree of Master of Science in Surgery for Graduate School of Medicine, University of Pennsylvania, Philadelphia.

DIAGNOSIS

The usual physical signs of fluid may often be misleading, especially in children. A thin layer of fluid over an area of consolidation may give bronchial breathing and increased fremitus. Careful observers have been unable to distinguish pleural fluid from solid lung, finding increased breath sounds in effusions and often decreased breath sounds in consolidations. The *x*-ray and needle are the most reliable guides in questionable cases when clinical methods leave one in doubt.[5] The *x*-ray plates of empyema show a curved dense shadow when taken in the sitting or standing posture. The prone position may give a general haze hard to differentiate from a solid lung unless the collection was loculated. There may be displacement of the mediastinum and trachea to the opposite side. Interlobar collections take place in the fissures and are diagnosed easier with lateral pictures which disclose, usually, elliptical densities corresponding anatomcally to the lung fissures.

TREATMENT

The broad principles of treatment are to remove completely the pus from the pleural space by adequate drainage, early enough to prevent chronicity and intoxication, yet not interfere with the vital capacity of the lung by too early open drainage. The high postoperative death rate in empyema during the war years was ascribed both to the early open operations and the virulence of the organism. It was then thought best to withhold operation until the patient's condition could be improved by such means as high caloric diet, transfusion, oxygen, and, if necessary, to aspirate repeatedly or use closed drainage; at all events, not to interfere further with the vital capacity of the pathologic lungs. As to just when the mediastinum is to be fixed sufficiently by the infection to withstand the onslaught of open drainage without danger, is not exactly known. It is surmised that in pneumococcus infections it takes about ten days and in streptococcus infections about two to three weeks for the pus to become thick and for the thoracic contents to lose much of their mobility. Many believe it is best to use closed drainage throughout, maintaining a constant low intrapleural pressure, thus encouraging lung expansion. The mortality in empyema, it is believed, has largely to do with the organism. In some epidemics the empyema itself may be an insignificant feature of a widespread invasion, the outcome of which will depend on the patient's resistance and immunity; the mortality will not be altered greatly by surgical procedures except, perhaps, to increase it by unwise action at inappropriate times. The mortality has varied greatly in different years, thus the enthusiasm for one type of treatment or another tried in the more fortunate seasons.

The details of treatment vary greatly. In general, very toxic cases may be treated conservatively, repeated aspirations can be done until the case is operable. If the patient is operable, a type of closed drainage with or without rib resection is usual. The types of closed drainage are many. Repeated aspiration alone has been tried with occasional success. The interrib puncture with tube drainage into a Kenyon bottle is used routinely by many. Mozingo leaves a clamped off catheter in the pleural space using suction every few hours. This treatment is particularly recommended for restless children whose motion interferes with tube drainage. A finger cot split at the end to cover the drainage tube is used occasionally by Lilienthal; this allows inspiration to close and expiration to force the exudate through the finger cot. The resection of the rib is deemed necessary when, through faulty mechanics, the drainage is not free, such as too thick a discharge or too small a rib space. Some conservative surgeons feel, however, that with sufficient care rib resection would not be necessary so frequently. Koster[6] recently produced a pneumothorax on the

sound lung to aid, by pressure, the drainage of the opposite pleural space. An objection to this method may be that the decreased vital capacity affected may occasionally end disasterously. Further, there are more satisfactory and safer methods in use. As to open drainage, any tube or button can be used but with no attempt made to prevent the aspiration of air into the chest through it. Closed drainage cases often become open in a few days due to leakage about the tube, but with constant care this need not be so. An operation recently advocated by Conners is to resect two ribs, open and pack the pleura widely as abscesses elsewhere are treated.

There have been many attempts to aid drainage by the use of suction, as with the Sprengel or Daryl Hart types of pumps. Most surgeons today do not feel that suction is necessary if the correct principles of treatment have been executed. Whether or not to use irrigating solutions, the most popular of which was Dakin's, was the subject of much controversy. Some felt adequate drainage to be sufficient as with all abscesses, while others hold Dakin's fluid stems the infection, dissolves debris and thins the exudate. Lilienthal[7] states that it may be used empirically, i.e., if a non-irrigated case is not doing well Dakin's solution may be tried, and the reverse. Muller irrigates with Dakin's and after sterilization introduces the solution of formalin and glycerin, used by Murphy. In his experience simple interrib puncture done during the meta-pneumonic stage had to be followed in two weeks by rib resection in 60 per cent of the cases, due to poor drainage. With patients in good condition having thick pus, he uses rib resection and closed drainage primarily (40 per cent), open drainage being discontinued entirely. Heuer[10] needed but three rib resections in 68 cases of simple empyema treated with interrib puncture and irrigation. His average healing time was thirty-seven days. Graham[8] prefers closed drainage always followed by rib resection and open drainage as soon as the process is a localized abscess. He states the average healing time of his cases to be five weeks.

HEALING

There is some contention as to whether blow bottles are effective in the reexpansion of the lung. Roser[3] believed that successive adhesions or granulation at the margins of the empyema cavity actually pulled the lung out, while forced expansion of the lung is followed by an equal deflation at the end of the respiratory exchange, leaving the lung essentially in the same position. Good drainage is all that is necessary to allow the natural mode of healing to take effect, while poor drainage allows adhesions to form between the pleura at abnormal locations, preventing the lung from being drawn out in its normal contour, favoring a permanent cavity and chronicity. This method of healing is said to be demonstrated visually in observing cases convalescing after the Connors open operation. Weisgarber,[9] however, held that the pressure changes caused by blow bottles, coughing and deep breathing did aid ultimate lung expansion.

Non-tuberculous chronic empyema is often attributable to the surgeon; either the drainage was poorly located through too small a tube, too early discontinuation of drainage, or loss of a foreign body in the abscess cavity. Occasionally, osteomyelitis of the rib occurs from the pressure of a large drainage tube, or the periosteum had been stripped from part of a rib to be retained.

MORTALITY

The patient is said not to die of empyema but of its complications. The postoperative death rate in empyema has been from zero to 50 per cent in different series. Heuer's[10] mortality figures from 1922 to 1930 with closed aspiration drainage were 22 per cent; with cases of simple empyema it was 1.4 per cent; and with cases having complication,

38.8 per cent. In 1922 the average mortality for all cases was 5 per cent; and for the streptococcic infections alone, 20 per cent. For the entire group in 1927 the mortality was 52 per cent; for the streptococcic type, 66 per cent; indicating the variations in virulence of different bacteria, and in different seasons. As to the age group; under two years the death rate was 40 per cent, over four years it was 35 per cent, between two and forty years the average mortality was 15 per cent. According to complication, mortality with bronchopneumonia was 65 per cent; with tuberculosis, 42 per cent; with lung abscess, 55 per cent; with peritonitis, 68 per cent; with septicimia and pericarditis, 100 per cent. Bohrer[11] records only 57 per cent mortality with complications of septicemia in empyema. Mortality due to early operation is shown in the series at Fort Riley.[12] In 85 cases from October, 1917, to January, 1918, having an early open operation there was a mortality of 61 per cent. In 96 cases from January to August, 1918, with the use of early aspiration and late thoractomy, the mortality was 15 per cent. The virulence of the bacteria may have changed in the second series but the effect of the early open operation on the vital capacity of those cases was certainly of detrimental effect to those patients.

Experience appears to teach that the fundamental elements needed for the cure of empyema are (1) closed drainage to avoid immediate catastrophe, and (2) adequate continuous drainage to prevent chronicity. Interrib puncture with irrigation appears more successful in certain hands than others. An especially trained staff and experienced nursing in this treatment are of great assistance in checking misadventures and recognizing difficulties early; perhaps by guarding carefully against a too early change to open drainage, or interference with siphonage and a development of pus that is too thick for the tube in use. At any rate, surgeons find interrib drainage often inadequate routinely.

TECHNIQUE OF FLAP OPERATION FOR EMPYEMA

The operation published by Nicoll is based on the principle of incising the pleura at one level and the skin at a lower level, thus the oblique opening would close on inspiration and drain on expiration. For better drainage a modified Wilson button was placed in the pleural opening at the point of a small rib resection and a strip of rubber dam was led from this button down under the flap out through the lower border of the horseshoe shaped flap incision.

A recent modification of the drainage apparatus for use in a flap, was a circular piece of rubber dam, 1 inch in diameter and 10 inches long, cemented on one end to the outer flange of the Wilson button and the other end attached to a Paul's tube connecting it to an empty bottle.

The advantages of this modification was that there was a pathway for the pus from the empyema cavity to a drainage bottle without, as formerly, saturating the entire wound; and also that in addition to the valve effect of the flap itself in preventing open drainage, the circular rubber dam, by closing on inspiration as a split finger cot would, was a double safeguard in this respect. In repairing the flap incision Michel's clips were substituted for the previous silk sutures which invariably were accompanied by infection, while the clips, not penetrating the flap wall were uninfected. The comparatively clean wound resulting from the circular rubber dam and the better coaptation of its edge, with clips, allowed the flap itself to heal more rapidly than formerly.

The following are two groups of case histories having flap operations for empyema. Those done in 1934 had the strip of rubber dam attached to the Wilson button. Those done in 1935 had the circular rubber dam attached to the Wilson button and led off into a bottle.

Case No. 8237. Male, aged three and one-half years, was admitted May 3, 1934, with

left lobar pneumonia. May 17, he developed signs of fluid in the left chest. May 22, chest tap disclosed thick green pus and on May 24 flap operation was done. Thereafter good drainage was maintained. June 15, empyema button pulled out. June 28, the patient was discharged healed.

Case No. 44196. Male, aged four years, was admitted January 17, 1934, with left lobar pneumonia and signs of fluid in left chest. *X*-ray plates disclosed left effusion from the apex to the base. He was operated January 19. Thereafter there was a profuse yellow discharge for three weeks. On February 24, roentgenograms showed the left lung expanded and the pleural space clear, with thickened pleura. Drainage had ceased. The patient developed scarlet fever before being discharged and was transferred to Willard Parker Hospital.

Case No. 48266. Male, aged fifty-one years, was admitted June 23, 1934, with a history of coronary thrombosis and a recent lobar pneumonia. The patient had pleural effusion in left chest. The pleural tap was purulent. Flap operation done on July 7, but he died July 8, of toxicity and cardiac failure.

Case No. 47700. Female, aged four years, was admitted May 23, 1934, with a history of lobar pneumonia, R.M.L. and R.L.L., for the past two weeks. May 24, disclosed signs of fluid in right chest from the apex to the base. May 25, pleura tap produced a thick yellow pus; May 26, flap operation done. June 14, *x*-ray films showed the right lung expanded, no fluid and a thickened pleura. The button was removed although there was still slight drainage. June 29, there was no further drainage and the wound had healed.

Case No. 47755. Female, aged eighteen months, was admitted May 11, 1934, with lobar pneumonia, R.L.L. May 18, *x*-ray plates disclosed effusion on the right side, from the apex to the base. Thoracentesis brought thick yellow pus. May 20, a flap operation was done. May 30, the Michel clips were removed. June 2, a complication of bilateral otitis media. June 14, a small amount of fluid in the base was seen on the *x*-ray picture. June 28, the lung was fully expanded, there was no discharge, and the wound had healed.

Case No. 47753. Female, aged twenty-eight months was admitted May 8, 1934, with lobar pneumonia R.L.L. May 18, *x*-ray films showed fluid in the right chest from the seventh rib to the base. May 30, chest tap produced a thick, green pus. June 5, a flap operation was done. Removing the clips on June 14, *x*-ray plates showed no fluid and a thickened pleura. June 28, the wound had healed.

The following cases were done in 1935 with the noted modifications in the drainage apparatus.

Case No. 63445. Male, aged eight years, was admitted June 19, 1935 with a history of right lobar pneumonia five weeks ago. The patient was not convalescing and had signs of a right pleural effusion. *X*-ray films disclosed a dense homogeneous shadow from the apex to the base of the right lung. A chest tap revealed a purulent fluid. July 15, flap operation was done. The patient had a good continuous drainage with rapid improvement clinically. July 22, *x*-ray plates showed a slight amount of fluid in the base, with the lung expanded. August 8, there was no drainage, the wound was closed, and *x*-ray film showed no fluid in the chest.

Case No. 61052. Female, aged twenty-two years, was admitted May 13, 1935, with lobar pneumonia, L.L.L. and showed signs of effusion in the left chest. *X*-ray plates disclosed fluid from the apex to the base. May 15, a chest tap was purulent. May 16, flap operation was done. June 7, *x*-ray films showed a clear chest. There was no drainage and the wound had closed.

Case No. 61617. Male, aged twenty-nine years, was admitted May 3, 1935. On April 23, 1935, he had had lobar pneumonia in R.L.L. and R.M.L., the sputum showing a type 1 pneumococci. The patient developed signs of a right empyema on May 2, a tap producing purulent fluid which on culture showed pneumococci type 1. (Appropriate serum had been used in the treatment of the patient's pneumonia on the medical wards.) May 3, *x*-ray plates disclosed a dense homogeneous shadow extending from the third rib to the base of the lung. The patient was too toxic at this time for operation and the pneumonia had not entirely subsided, therefore resort was made to repeated chest taps and supportive treatment. May 11, the patient's condition had improved and a flap operation was done,

after which he convalesced uneventfully. May 25, roentgenograms showed a slight amount of fluid at the base. June 6, *x*-ray examination showed a clear chest. No drainage was present and the wound had healed.

Case No. 61743. Female, aged three and one-half years, was admitted June 10, 1935, for a left suppurative pleurisy. She had measles three weeks ago and developed pneumonia as a complication. June 11, a tap produced thin pus with staphylococci and streptococci on culture. June 12, *x*-ray films indicated a massive effusion in the left chest from the apex to the base. The chest wall was very edematous. June 15, a flap operation was done, after which the drainage was slight and practically ceased by June 17. The empyema button was found to be patent on testing it by injecting saline, and the flap was seen visually to be working. The patient did not have sufficient resistance to the infection to produce pus and continued steadily downhill despite transfusions and supportive therapy and died on June 28. Autopsy disclosed an underlying gangrene of the left lung and purulent pneumococcus pericarditis.

Case No. 57245. Male, aged sixty-one years, was admitted January 23, 1935. He had had a left lobar pneumonia one month ago from which he had not recovered. January 24, *x*-ray plates disclosed an effusion in the left chest. January 26, a chest tap yielded a thick green pus, culture of which showed streptococci. February 2, a flap operation was done. February 10, *x*-ray film showed only a small amount of fluid in the chest. February 28, the drainage had ceased; *x*-ray plates revealed a clear chest. The wound had healed.

Cases No. 62445, 64223, and 63632, were all essentially similar to the last case with the exception that the right lung was affected twice.

The 8 cases done in 1935 with the modified drainage apparatus had an average healing time of four weeks. The cases of 1934 and those done previously had an average healing time of five weeks.

COMMENTS

Some comments that may be made are that in the fatal cases presented it may be seen from the autopsy result how futile operative procedures are in overwhelming infection. Also from the similarity in the course of most of the cases, it appears not to matter what the infecting organisms are; if they are not virulent enough to give fatal complications, they will usually clear up promptly with good drainage.

A few clinical suggestions to be kept in mind for a successful flap drainage are that the rib resection must take place near the bottom of the empyema; that the skin flap should be at least four inches square; that a finger must be kept in the pleural incision right after it is made until the Wilson button is inserted to prevent a pneumothorax; the patency of the tube must be tested before the wound is closed by looking for the drainage of free pus, as a very large fibrin clot might block the aperture of the button; saline through a syringe may be used to dislodge it. In bed, the patient must be careful not to be on, or kink, the tube and block free drainage. Otherwise, postoperatively, this method is ideal as no system of closed drainage tubes has to be constantly observed, and there is no great danger of early pneumothorax. The patient can be tended easily and practically nothing can go amiss except the patient's kinking his tube. Very occasionally a large piece of fibrin blocks the button, whereupon the button may be removed with a slight delay in convalescence. However, the smaller tubes used in bottle drainage would certainly become obstructed in such an instance.

While the modified drainage apparatus here presented was intended originally for simple empyema, it appears, theoretically, very suitable to maintain closed drainage in empyemata secondary to lung abscess and pulmonary tuberculosis when drainage is indicated. Five cases of lung abscess complicated by empyema have been treated by a flap operation with good recoveries in all.

On the First Surgical Service of Fordham Hospital, from 1930 to 1934, there were 22 flap operations done for simple empyema, using the Wilson button and a strip of rubber dam to guide the drainage. The average healing time was five weeks. There

were 3 deaths; 2 due to bacterial virulence and one to a concealed gastrointestinal hemorrhage. In the same period of time there were 18 cases of empyema on the Second Surgical Service using simple interrib puncture and tube drainage. The average healing time was seven weeks. It was noted that cases operated later than three weeks after the onset of the empyema took a longer time to heal.

The cases operated in 1935 with the modified drain described had an average healing time of four weeks, with the one mortality described. There was no chronicity.

CONCLUSIONS

Closed tube drainage with constant supervision allows good drainage of an empyema with an average healing of seven weeks.

The flap operation, with the modified drain for empyema here presented, gives an adequate and constant drainage which demands no special postoperative technical care on the ward, is less liable to accidents and is not complicated by chronicity.

There was an average postoperative course of four weeks after the flap operation for empyema when using the modified drainage apparatus herein described.

This work has been done through the courtesy of Dr. A. Nicoll, of the First Surgical Service of Fordham Hospital, New York City.

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CRITICAL ANALYSIS OF METHODS OF TREATMENT OF RECTAL CARCINOMA, PARTICULARLY ELECTROCOAGULATION

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CARCINOMA of the rectum, frequently considered a rather unusual type of carcinoma is fifth in the list of primary seats of cancer, in fact, constituting about 6 per cent of all carcinomas found, about 25 per cent of all carcinomas of the gastrointestinal tract and about 50 per cent of all carcinomas of the large bowel, according to Rankin.[4] Because of its comparatively hidden location, it is seldom discovered early, the symptoms are vague and indefinite, and it is only after definite signs of blood in the stool, partial obstruction and pain intervene that a diagnosis is usually made; this, in spite of the fact state Wood and Wilkey[1] that 95 per cent of carcinomas of the rectum are located within four inches of the anus and are palpable on digital examination.

The success that has been achieved to date in the treatment of carcinoma in general has been in those locations accessible from the exterior. Remarkable advances in the past twenty years have been made in the treatment of skin cancer, cancer of the lip, more recently in cancer inside the mouth, on the tongue, in the throat and in cancer of the breast and uterus. Success in these locations has been due to the fact that these cancers can be completely destroyed before metastasis takes place. Where metastasis has occurred the great majority of cancers in these locations terminate fatally.

The general consensus of opinion regarding cancer of the rectum seems to be that it is a hidden lesion, that while the local growth is slow, metastasis takes place comparatively early to regional lymph nodes or through the blood stream to the liver, and that our methods of local treatment, either surgery, *x*-ray, radium or electrocoagulation, because of this are relatively futile. The truth is, the great majority of carcinomas of the rectum are readily palpable and if at intervals a routine digital examination was made of the rectum in every case, male and female, that comes within the cancer age, thirty-five to seventy years, many cases of carcinoma of the rectum would be discovered at a time when local destruction could be performed completely and successfully. Because of the anatomy of the rectum and because of the pathology of the growth, metastasis is slow and it is only after many months that even local metastasis occurs.

ANATOMY OF THE RECTUM

The rectum is divided into three portions, the upper which is a continuation of the pelvic colon, the middle or second portion normally considered the ampulla, and third, the anal canal. The anal canal is usually 1 to 1½ inches long, the ampulla 3 to 3½ inches long, and the first or pelvic portion of the rectum measures one inch in length; thus the total length of the rectum is 5 to 6 inches. The length of the anal canal and ampulla together is usually 4 to 5 inches. The rectum begins at the level of the third sacral vertebra and ends where the bowel pierces the pelvic floor, it descends along the front of the sacrum and coccyx in a curve and then forward to the anal opening.

The upper two-thirds of the rectum has a partial covering of peritoneum, in front and on the sides at first, and later in front only; while the lower third has no peritoneal covering whatsoever. When the mesocolon ceases at the end of the pelvic colon, the two layers separate, leaving the back of the rectum destitute of peritoneum, therefore, the greater part of the rectum lies behind and beneath the pelvic peritoneum. It is true the peritoneum is carried forward to the base of the bladder in the male and to the posterior wall of the vagina in the female but the level at which the reflection

of peritoneum takes place from the front of the rectum is one inch above the base of the prostate in the male or an equal distance in the female; from 3 to 4 inches above the anus.

Therefore, the front of the rectum has no peritoneal covering for a distance of 3½ inches and the back of the rectum is free from peritoneum for 5 to 6 inches above the anus. This matter of reflection of the peritoneum is extremely important in any attack, radium, surgery or cautery, upon the carcinoma from below it.

The blood supply to the rectum comes chiefly from the superior hemorroidal artery, a branch of the inferior mesenteric which travels along the posterior surface of the rectum and divides to form its two branches immediately below the reflection of the peritoneum.

Structurally, the rectum is constructed of four walls or layers, (1) an outer coat formed of peritoneum, and where the peritoneum is absent, of connective tissue, (2) an outer longitudinal and inner circular layer of smooth muscle, the latter circular fibers are thickened to form the internal spincter, (3) the submucous coat composed of loose areolar tissue, and (4) the mucous coat in the rectum proper lined by columnar epithelium and in the anus by squamous epithelium.

PATHOLOGY

Wood and Wilkey[1] have made an extensive study of 100 specimens of carcinoma of the rectum removed at operation and have found that the highest lymphatics involved were at the point of division of the superior hemorroidal artery. They state that the spread of carcinoma of the rectum by the blood stream is an accident, that the spread of the growth is chiefly by local continuity between the muscle layers of the rectum and practically always in a circular plane because the invading carcinoma cells can follow the circular muscle fibers easier than the outer longitudinal.

While there are a number of types described, such as adenocarcinoma, colloidal carcinoma, etc., beside the comparatively rare squamous cell carcinomas at the anus involving the anus and anal canal, all the carcinomas of the rectum arise from columnar epithelium and are adenomatous in character. There are two types, (1) the papillomatous that grows outward into the lumen and (2) the ulcerative, invasive type that penetrates into the deep structures. This characteristic of growth resembles to a marked degree the carcinoma found in the cervix of the uterus. Of the 100 specimens examined by Wood and Wilkey following surgical removal, 49 were entirely free from metastatic glands; of the remaining 51 cases, 14 had only one gland involved, 13 had two glands involved and 24 showed involvement of more than two glands, none being above the bifurcation of the superior hemorroidal artery. These findings are in marked contrast to those reported by the majority of pathologists who gained their knowledge from an examination of specimens taken after death which show widespread metastasis to the lymphatics, peritoneum and liver. In only one of the 100 cases reported by Wood and Wilkey was an invasion of the peritoneum found and in only one case was there invasion of the levator ani muscles.

Carcinoma of the rectum is extremely slow in development, extending over two or three years. More than half of the rectal carcinomas are between two and four inches above the anus (R. Williams) but Kraske says most of them are in the upper rectum.

Extension beyond the intestinal wall occurs late and metastasis is less frequent than with similar growths in other regions.

DIAGNOSIS

Diagnosis should not be difficult if examining physicians made it a rule to examine the rectum digitally. As stated, 95 per cent of carcinomas of the rectum are palpable. On the other hand the symptomology is vague and until loss of weight, partial obstruction, pain, ulceration with pus and blood occur there is little to direct the patient's attention to his condition. Usually even these marked symptoms persist for six months to a year before they

receive proper attention from the patient himself or his physician.

Bargen and Leddy,[3] found in a series of 200 cases that the earliest symptom was bleeding, pain occurred next, then constipation and finally diarrhea. Usually a rectal examination was not made, so they found, because the patients frequently objected to such an examination and in an attempt to make the best of the situation, physicians prescribed some palliative measure and merely delayed correct treatment.

Wood and Wilkey[1] further state that the histories of all their 100 cases indicated a long period of diarrhea or other bowel disturbance, pain or bloody stools before a positive diagnosis was made. Digital examination in many of these cases would have resulted in an earlier discovery of the disease.

SURGICAL MANAGEMENT OF CARCINOMA OF THE RECTUM

"Carcinoma of the intestine is a favorable field for aggressive surgery," Ewing[2] states. Carcinoma of the rectum has been considered strictly a surgical condition for years. In many surgical clinics colostomy is considered a necessary and important preliminary surgical procedure and whatever is done to remove the carcinomatous lesion is done after the colostomy. Usually after the colostomy is established and working the whole of the rectum is dissected and removed by either abdominal or perineal or combined abdominoperineal operation; in many instances accompanied by partial removal of the sacrum. This constitutes a formidable surgical procedure; the colostomy is extremely depressing and annoying to many individuals and after its establishment makes them shrink from association with their fellows. The dissection and removal of the rectum carries a very high mortality rate of 10 to 15 per cent and even under the best circumstances, only 50 per cent of the cases that come to the surgeon would be, by the most liberal interpretation by the most daring surgeon, considered operable. In spite of these serious handicaps of a high mortality and low per cent of operability, the results of radical surgery, based upon five year survivals, have been remarkably good.

Rankin,[4] reporting on 753 cases of cancer of the large bowel of which 300 were located in the rectum, was able to report 114 cured (five year survival) or 38 per cent of the surgically treated cases with an operability of approximately 50 per cent. Lahey and Cattell,[5] in 66 cases, had an operative mortality of 13.6 per cent with a five year survival of 42 per cent. Their operability was also 50 per cent, thus they saved 1 case in 5, or 20 per cent of those seen. Coffee[6] further confirms these findings on 56 cases.

De Pemberton,[7] in 1934, in recording all cases of carcinoma of the large bowel from the cecum to the anus to report the end results of carcinoma of the rectum, found a five year survival as follows:

FIVE YEAR SURVIVAL

Site	*Per Cent*
Cecum	51.8
Colon	48.9
Sigmoid	40.67
Rectosigmoid	36.9
Rectum	35.8
Anus	42.8
Total of all types	42.8

These results indicate that although the surgical procedure is difficult and formidable, the results from surgery are remarkably good in comparison to the successful results of treatment of carcinoma in other parts of the body.

RADIATION THERAPY

Both radium and *x*-ray have been tried. Because the adenocarcinoma cell, as compared with the squamous carcinoma cell, is highly differentiated, and because the more highly differentiated cancer cells are more resistant to the effects of irradiation, *x*-ray and radium therapy have not made the progress in the treatment of carcinoma of the rectum that has been achieved in other locations with other less differentiated types of cells. The mucous membrane of the rectum is also highly sensitive to the radium reaction and many authors believe the distress and pain produced by the application of radium into the rectum does not warrant its use, at least alone. Bowing,

Frick and Harper,[8] reporting the results of treatment of carcinoma of the rectum by radium do not give any statistics but cite a number of interesting cases which apparently have been cured for more than five years by the use of radium alone. Bowing and Frick[9] in a later article report that at the Mayo Clinic from 1915 to 1931, 800 cases of carcinoma of the rectum, anus and rectosigmoid were treated with *x*-rays and radium. In 50 per cent of these cases the lesion was high in the rectum, 37.8 per cent in the ampulla and in 12 per cent in the anus. Two hundred and forty-eight, or practically 50 per cent of these cases, were considered to be inoperable and palliation was all that could be reasonably expected. They used so many different techniques, many of which are now obselete, that no discussion of their technique is included. In reading their reports one is not impressed with their results but in inoperable cases *x*-ray and radium therapy apparently gave relief of symptoms and made the patients much more comfortable. Many of the cases were treated without colostomy. Bowing believes the problem of treatment of carcinoma of the rectum by radium is largely a matter of developing a suitable method of application.

Schreiner[10] and O'Brien, reporting in May, 1931, on 210 cases of carcinoma of the rectum and anal canal treated between 1914 and 1925, inclusive, using radium by a contact method found a five year survival of 17 per cent in the group of cases that ordinarily would be considered operable. In the 142 inoperable cases the five year survival was only 1.4 per cent.

Binkley[11] in reporting on 238 cases treated between 1926 and 1930 says that of this large number of cases only 25 were "favorable" and 213 were "unfavorable," although all but 18 received some palliation from irradiation treatment.

183 lived over 6 months
112 lived over 12 months
65 lived over 18 months
35 lived over 2 years
20 lived over 2½ years
9 lived over 3 years
1 lived 4 years and 8 months

Total 425

Of the 25 "favorable" cases he would have considered only 15 as operable. As far as prolongation of life is concerned, Binkley's report is not very encouraging. In a subsequent article Binkley[12] discusses his technique and states that radium applicators applied to the surface of the growth and the insertion of radium element needles has a very limited use. In his opinion external radiation by both *x*-ray and radium does not furnish enough irradiation to destroy the whole growth except in rare instances and implanted gold seeds constitute the best method of treatment, but this is not without danger as sloughing may be produced by using too many seeds. However, unless more than 50 mc. are used the reaction is seldom too severe. He states that in approximately 50 per cent of the cases colostomy was necessary before giving the irradiation treatment because of the degree of obstruction. His usual plan of treatment is to use from 3900 to 9100 millicurie hours by implantation and 900 *r* *x*-ray over each of six fields. Using this improved plan with "adequate dosage" in 27 cases under observation for more than two years, 20 cases are clinically free of carcinoma and 13 of these patients were under observation for more than four years and are clinically free, or 65 per cent apparently cured. This is indeed a much more encouraging report than that given by Bowing or Schreiner and the probable explanation is that more adequate *x*-ray and radium dosages were administered.

Schreuss[13] has found that in the inoperable cases, while colostomy makes the patients perhaps more comfortable it has not prolonged life and he reports that Kuttner as well as Hartman have found that 70 per cent of these inoperable cases died in less than a year. However, if deep *x*-ray treatment is added to the colostomy, considerably better results are obtained. Van Schmitt, cited by Schreuss,[13] says that after this combination 66 per cent were alive at the end of one year, 40 per cent lived two years, 28 per cent lived three years and 8 per cent lived four years, while with colostomy alone only 30 per cent survived one year, 15 per cent three years and 6 per cent four years.

Tailhefer,[14] says, "Radium applied to the rectal ampulla does not cure but sometimes has a palliative effect which is frequently as good as that secured by colostomy. Radium implantation has produced better results than radium by contact." He advises the application of radium into the posterior vaginal vault to avoid the severe irritation of the rectum and states that this gives results superior to those obtained when the radium is applied in the rectal cavity. In his experience in operable cases radium has not given any better results than surgery alone. In the inoperable cases *x*-ray by the Coutard method has been more efficient than the use of the 4 gram radium pack at a distance of 10 cm. His conclusion is that irradiation is of great value as a palliative measure but has not proved of much value in the cure of rectal carcinoma.

The consensus of opinion, therefore, seems to be that in operable cases surgery is far superior to irradiation but that irradiation is of great value for the relief of symptoms in the inoperable group. An occasional cure by irradiation alone would indicate that its possibilities are by no means exhausted and I quite agree with Bowing that the need is for further study. With improvement of the methods of application better results will be achieved.

ELECTROCOAGULATION

A third and comparatively more recent type of treatment of carcinoma of the rectum, electrocoagulation needs to be considered. In view of the fact that 95 per cent of the carcinomas of the rectum are within 4 to 6 inches of the anal opening and the majority metastasize slowly, complete destruction of the local growth should be possible in many instances. The literature would indicate, however, that few attempts of this kind have been made.

Strauss and Strauss[15] report 21 cases treated and under observation for two to three years; 16 gave good results but they do not state for how long and 4 cases had severe secondary hemorrhage from six to twelve days after electrocoagulation. This hemorrhage was controlled by tightly packing the rectum with gauze. In 15 cases a preliminary colostomy and in one an ileostomy had been done and no preliminary surgery in 5 instances. They state, however, that all of the 21 cases treated by this method were inoperable in the ordinary surgical sense. They feel that the patients were improved remarkably.

Bettman[16] reports the use of surgical diathermy for palliation only in advanced, inoperable cases with relief of toxic absorption.

Florcken,[17] in 1933, reported 12 cases in which the carcinoma was inoperable and fixed with some invasion of the bladder or vagina. All but one had a preliminary colostomy followed by an exposure of the rectum by resection of the sacrum under spinal anesthesia followed by electrocoagulation of the accessible growth. In several instances he had severe secondary hemorrhage from fairly large vessels five days after the electrocoagulation. This procedure, he claims, is of value in these inoperable cases for the relief of pain, tenesmus, bleeding and odor. He also mentions dilating the rectum and coagulating with a "bullet-like electrode" without colostomy in suitable cases with brilliant results, but states that as yet he has not had sufficient experience. He concludes that operable tumors should be removed surgically, but that electrocoagulation is of value in relieving many of the distressing symptoms in inoperable cases.

Further reports on electrosurgical methods have been made during the past few years. Schurch[19] finds that electrosurgery is so new it is difficult to compare results with older established surgical methods. He quotes Bervan, of Stockholm, who has used one electrode in the rectum and the other on the patient's skin, and also quotes Grenzfalle who recommends a method for inoperable cases in which three to five weeks after a colostomy he tried to remove the tumor by sacrectomy or resection with the electric cutting knife or opens the intestine after sacrectomy and cooks the growth under the guidance of the eyes and fingers but always with a catheter in the bladder. This, of course, is impossible if the peritoneum is invaded.

Julien[20] describes a method of diathermic currettage and then leaves an especially constructed sound carrying radium in the place of the tumor. He uses colostomy if the patient will consent, otherwise not. With a long needle deep in the tissues but without entering the rectum he injects a local anesthetic at four points. He then follows the opening through the annular carcinoma with a Hegar sound, replacing it with a rubber sound and then coagulates and removes the tissue by morcellation with the diathermic loop. When a small rectoscope can be passed he examines and coagulates the superior portions of the tumor. Without the colostomy he waits a few days and then introduces the radium.

In a very early removable carcinoma that felt like a polyp on the anterior wall of the rectosigmoid 8 cm. from the anus, biopsy of which revealed a carcinoma, Dixon and Beaver[21] fulgurated the mass. Five months later only a small scar was seen. They had performed a temporary colostomy in advance of the fulguration. Six months later the patient suffered a cerebral hemorrhage and at autopsy gross and microscopic examination of the rectum, revealed no evidence of carcinoma. They further state that they do not approve of this method as a general rule but have treated a few cases in this manner with remarkable results when the growth was movable and of a low grade of malignancy. In 5 early cases Bowing[8] used electrocoagulation followed by radium with brilliant results and believes that it may be a step towards eliminating the permanent colostomy.

Strauss[22] et al. in a more recent article report their results on 42 patients treated to date. Originally they used electrocoagulation when the tumor was fixed, when the patients were very old, or when there was some contraindication to radical surgery but during the past seven years, because the results were so satisfactory, they have used electrocoagulation in practically all of their cases in which the carcinoma was located below the sigmoid. Their results are particularly interesting because these patients received endothermy alone. Colostomy was not performed in 22 of the patients and they report as much gain in weight and improvement as in the others; in only 5 cases did they encounter secondary hemorrhage and in only one case a rectal abscess developed; 2 of the patients died within ten days following the application of the endothermy, one each of peritonitis and pneumonia.

In describing their technique they state that for several days before the electrocoagulation the patient was given daily one ounce of magnesium sulphate in seven ounces of water, divided into sixteen doses, followed by enemas of the lower portion of the sigmoid and the rectum was also cleaned by a suction apparatus. They coagulated successfully tumors within 4 to 6 inches of the anus. Early in their work they coagulated deeply and thoroughly but they have concluded that it is best to coagulate superficially and not too severely and repeat it at the end of several weeks for a second, a third and even a fourth application, if indicated, the need being determined by rectal examination. This method, in their opinion, results in less scar formation and hence less stricture.

During the past nine years we have had an opportunity to treat 15 cases of carcinoma of the rectum by electrocoagulation without colostomy with only one immediate surgical death and one postoperative hemorrhage. In 10 of these cases deep *x*-ray therapy at 200 K.V., 50 cm. distance, .5 mm. copper filter, through two large fields over the front and back of the pelvis was used. In 10 cases radium (Table 1) was also applied to the seat of the carcinoma in the rectum following the electrocoagulation but the main dependence was placed upon the electrocoagulation and the irradiation therapy was used merely as an adjunct.

The results of treatment to date are given in the accompanying table. It will be seen that 7 of these cases have been treated for more than three years, 4 of them would have been considered inoperable. In the 3 cases that were considered operable, one lived for six years dying of myocarditis. The other 2 cases are appar-

TABLE I

RESULTS OF ELECTROCOAGULATION AND RADIATION THERAPY IN TREATMENT OF CARCINOMA OF LOWER TWO-THIRDS OF RECTUM

Name	Date	Sex	Stage	Location	Duration before Treatment	Colostomy	*X*-ray Therapy	Radium	Coagulation	Length of Life after Treatment	Cause of Death (Autopsy?)	Recurrence	Remarks
1. R. U.	1925	F	Operable ++	Anal canal	6 months	.....	.....	1200 mghrs. 1 mm. brass	Yes	6 years	Myocarditis	No	Hemorrhage ten days after.
2. A. A.	1927	M	Inoperable +++	Ampulla	18 months	.....	2 fields 3200 *r* .5 cu.	1200 mghrs. 1 mm. brass	Yes	7 years	Recurrence	Yes	
3. Mrs. C. H.	1928	F	Operable ++	Anal canal	1 year	.....	3200 *r* 2 fields .5 cu.	640 mghrs. 1 mm. brass	Yes	8 years	Still alive and well	Yes Coagulation 1 year later	No evidence of trouble after 8 years.
4. J. K.	1928	M	Inoperable ++++	Ampulla	18 months	.....	3200 *r* .5 cu.	.....	Yes	18 months	Carcinoma rectum	Yes	
5. L. D.	1930	M	Inoperable +++	Ampulla	1 year	.....	2400 *r** .5 cu.	3840 mghrs. 2 mm. Ag.	Yes	2 years	Carcinoma rectum	Yes	Much pain after radium.
6. L. B.	1931	F	Inoperable +++	Ampulla	9 months	.....	2800 *r* 2 fields .5 cu.	2880 mghrs. 1 mm. brass	Yes	3½ years	Hypertension, myocarditis	No sign of carcinoma	Ulceration caused by radium.
7. E. H.	1932	F	Operable ++	Ampulla	10 months	.....	2400 *r* 2 fields .5 cu.	.....	1932 1933	5 years past	Perfectly well after 3 years	No	
8. A. F.	1933	M	Inoperable +++	Ampulla	7 months	.....	3000 *r* 2 fields .5 cu.	1920 mghrs. 2 mm. brass	Yes	14 months	Carcinoma rectum	Yes	Also had *x*-ray at 600 K.V.
9. C. A.	1934 June	M	Inoperable ++++	Anal canal	18 months	.....	3200 *r* 2 mm. cu	.....	.....	1 year	.....	Yes	Had radium before elsewhere.
10. B. T.	1934 Mar.	M	Inoperable +++	Ampulla	1 year	.....	.....	2880 mghrs. 2 mm. brass	Yes	Alive now 2 year O.K.	.....	No	Much pain after radium; O.K. now.
11. W. B.	193? Aug.	M	Inoperable +++	Ampulla	8 months	.....	.....	2000 mghrs. 1 mm. Pt.	Yes	Alive now April, 1936	.....	Yes	No pain after radium.
12. H. C.	193? Oct.	F	Inoperable +++	Ampulla	10 months	.....	4000 *r* 2 fields	480 mghrs. 1.5 mm. Pt.	Yes but not thorough	Alive April, 1936	.....	Yes bad	Marked relief of symptoms.
13. W.	1934 Nov.	F	Inoperable +++	Upper rectum	9 months	.....	4800 *r* 2 fields	2600 mghrs. 1.5 mm. Pt.	No, too near peritoneum	Alive	.....	Yes	
14. C. S.	1933	F	Inoperable +++	Upper rectum	10 months	.....	.....	.....	Yes	5 days	Peritonitis	.....	Peritonitis as result of perforation.
15. I.	Dec. 1933	F	Inoperable far advanced ++++	Ampulla	3 years	.....	.....	.....	Yes	Alive with recurrence; needs more treatment	Alive	Yes	Had complete obstruction.

ently cured, that is, are free of all symptoms of carcinoma of the rectum. Of the 4 cases considered inoperable, one lived for seven years, symptom free for six and one-half years and then died of recurrence. One other inoperable case lived for three and one-half years and then died of hypertention and myocarditis. On examination a few months before death no sign of carcinoma was found in the rectum. These results certainly compare favorably with those reported for radical surgery.

For electrocoagulation the patient was anethetized fully, the rectum dilated widely and a large, unusually long vaginal speculum was used to expose the field. Following this, a button electrode on a long handle was used. A special light was attached to the speculum to illuminate the field of operation thoroughly and satisfactorily. The amount of electrocoagulation, of course, is determined by the extent and the character of the carcinoma. It was our attempt in every instance to coagulate thoroughly the carcinomatous mass and still avoid invasion of the bladder and peritoneum. If on digital and proctoscopic examination we felt that the carcinoma extended more than 4½ inches above the anus in front or 5½ inches in back we did not treat by this method.

Following the electrocoagulation the radium was applied directly to the charred base. In the first treated cases 1200 mghrs. in a capsule of 1 mm. brass was used. Later the filtration was doubled and the dosage increased, varying approximately from 2400 to 3000 mghrs. The *x*-ray was administered in a full erythema dose over two pelvic fields anteriorly and posteriorly. As stated, this radiation therapy was considered of some value but the main dependence was placed upon the electrocoagulation.

It is true that this group of cases is small, but as Strauss[22] has found compares favorably with the results that have been achieved with more radical surgery and while no conclusions can be drawn, I agree with Strauss that the method is worthy of further study and with improvement in technical procedure and earlier diagnosis that better results can be achieved.

Latterly, we have omitted the use of radium in the rectum because of its distressing reaction. Stenosis of the rectum is the most annoying complication following this deep electrocoagulation, but can be controlled by subsequent frequent dilation repeated at intervals of every few weeks or months.

SUMMARY

The great majority of carcinomas of the rectum can be reached by the examining finger and are located below the peritoneal floor. Such carcinomas are accessible for treatment through the anus by (a) surgical excision, (b) irradiation and (c) electrocoagulation. In our hands, electrocoagulation in conjunction with irradiation has proved quite as satisfactory as the results reported for radical surgical excision.

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OBSERVATIONS AND AIDS IN RECTAL AND VAGINAL EXAMINATIONS DURING LABOR

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THE scarcity of the literature on the subject of rectal examination and the vagueness and meagerness and often misleading information derived both from the literature as well as from the examination, have led to making a thorough study of the subject as compared with the vaginal, intracervical and intrauterine findings. The salient points are here presented which should prove to be of service in the majority of cases.

As a rule no difficulty is encountered before the cervix is entirely obliterated, particularly when it is low down and centrally located. But it may be situated eccentrically, in an extremely lateral or posterior position. In vaginal examinations, where the fingers have a wide sweep, there is little or no difficulty in feeling the cervix. It is different in rectal examinations, where the reach of the finger is shortened by the intervening perineal, anorectal and vaginal structures and its movements limited by the spasmodic action of the sphincter ani muscles, making the palpation of the cervix difficult if not impossible. The os may be in the normal position, entirely effaced, undilated or dilated to an extent but so thinned out and so closely in contact with the head or membranes that no line of demarcation can be recognized on rectal examination. In such cases a diagnosis of full dilatation is often made when actually there is little or none.

The vaginocervical junction presents a class of cases causing confusion on rectal examination. Unless the examiner is cognizant of its existence, or it is present in an exaggerated form, the direct pressure incident to the vaginal examination usually obliterates this soft ring unobserved. It may, however, be recognized by gliding the fingers carefully along the vaginal vault concentrically toward the cervix. The comparatively loose and rough, papilla studded vaginal surface will fold over an actual elevation if labor is not sufficiently advanced, or become puckered into an elevation as it meets the resistance of the less yielding ruga or papilla-free, "oily-velvety" mucous membrane of the remnant of the portio vaginalis. On indirect palpation through the rectum this prominence is more pronounced, as the examining finger usually can reach only the inner limit of this ring, thus not only failing to obliterate it but to even make it more pronounced. This often leads to a mistaken diagnosis of two to four fingers dilatation. Where this condition obtains, dilatation as a rule is slow and cervical tears more common than when this phase is not present. The exaggerated form of this phase has already been mentioned as the partial inversion of the vaginal vault with the resultant ring formation in a previous publication.[1]

Another pitfall is the internal os, and a description of its behavior will also, in a general way, enlighten the mechanical processes involved in the obliteration of the cervix. When the internal os is not obliterated it can be felt, on palpation of the vaginal surface of the uterus, as a ring, of the thickness of a fine pencil or one of the varying segments of its tapering point, which can be rolled under the finger. It may have the same lumen as that of the external os or one to one and a half fingers larger. With the fingers within the uterus it can often be felt for some time before labor has started and during its early stage, as a tense or relatively firm circular frame forming, in conjunction with the external os

and the intervening space, a close duplication of the fossa navicularis of the vaginal introitus, the external os corresponding to the fourchette or posterior commissure and the internal os to that of the base of the hymen, with the distinction that this fossa extends all around the cervix, while that of the vagina forms but an arc of a circle. If a transverse or longitudinal section were made through the cervix, this fossa would be, as a rule, deeper, that is, more pocket-like, in the posterior segment. On rectal examination the unobliterated internal os gives the deceptive impression of an amount of dilatation equal to its lumen. But it can be distinguished from the external os, since pressure with the fingers on the internal os will cause the patient to feel a distinct, localized, referred cramp-like pain in the uterus, usually in the lower, anterior portion; the external os is insensitive to such pressure. Sometimes, and this also takes place before or during the early period of labor, the external os is found to be dilated one or two fingers, the rest of the cervical structures and internal os filling the intervening space, leaving an opening for only a finger tip or less within the internal os. More often the reverse position is found, the external os is about one finger dilated and the internal os, two or more fingers. But regardless of the position of the internal os, unless it is paralyzed by overstretching, pressure on it will cause a referred cramp-like pain, rectally as well as vaginally. Pressure on the external os does not cause such a reaction unless the internal os is subjacent to it. Neither does pressure on the vaginal ring, as described, cause any pain unless the internal os is subjacent to it. When two or three sensitive incomplete finer rings or arcs are present, they are probably formed by a splitting up of fibers of the internal os or of the circular fibers of the cervix, or of a combination of both. Pressure on them rectally or vaginally elicits tenderness at the point of pressure only. Multiple variously sized and shaped insensitive curves or lines and irregular elevations are often felt both vaginally and rectally through the thinned lower uterine segment or membranes. They are formed by bundles of hair of the fetal head arranging themselves in that fashion, or by the folds of the scalp or both.

It may not be amiss to repeat here a description written some years ago[2] of an anatomicopathological condition bearing on the structure of the so-called undilatable cervix. The fibers constituting the internal os and probably also bundles of "the circular muscle fibers of the cervix as they are put on the stretch by the descending head, become converted into long, tense, sharply edged transverse ridges estimated at about $\frac{1}{32}$ of an inch in diameter and arranged in conical terraced fashion with the base at the point of impingement of the largest presenting circumference of the head and the narrow end at the external os." A similar condition of the vagina is also described. To a less marked degree this condition is present in most of the tardy labors.

Since 1927, when this description was published, I have had a minimum of 15 cases of anomalous cervix which might properly be classed, for practical purposes, under the category of the "absolutely undilatable." The pelvic measurements were normal in all of them. They were characterized, after labor had been well established, by strong and prolonged uterine contractions over periods of hours and even days, but without making progress even when supplemented by manual stretching and that of the hydrostatic bag. To palpation, after the fingers had passed the external os, an obstruction was encountered which is identical with the formation present in the lower segment of the uterus immediately after delivery of the placenta. It is suggestive of Bandl's ring, which for some reason developed before labor had started or in its early stage. This whole strange phenomenon is most likely a pathological manifestation of the internal os only. In the majority of these cases I had been able to dilate the vaginal part of the cervix to the extent of four or five fingers, and the internal os to one or one and a half

fingers, only to retract soon after the force was withdrawn. Even after the spontaneous expulsion of the hydrostatic bag, actual dilatation was but very little or not at all influenced.

In two of these cases where I have done a low flap cesarean section to terminate the labor, the os, soon after the delivery of the placenta, was found to be hermetically sealed at its uterine end, making the insertion of a drain impossible. One of these 2 cases was a breech; it was also the only breech in the series and in every respect the most formidable. It is noteworthy that irrespective of the strength of the uterine contractions in this whole series of cases the descent of the lower pole during such contractions had been negligible.

These mentioned varieties of undilatable cervix take place in aged primiparas or in multiparas with a long interval of sterility.*

There is still, however, a more common form of so-called undilatable cervix which under the subheading of "soft undilatable cervix with relation to attitude and delivery of the child"[2] I have already in part described and which to palpation feels normal but will not dilate sufficiently. The outstanding feature in the majority of these cases is a pinpoint external os with a cartilaginous-like border which persists even after hours of active labor. They occur, as a rule, in rather young primparas with an absence or practical absence of amniotic forewater and where the head was fully engaged and the cervix effaced weeks before labor had started. In the cases where pituitrin, quinine or castor oil or morphine had failed to complete the dilatation of the cervix, or more correctly, to tear it, I have made, successful forceps deliveries at a time when there was no more than four fingers dilatation, by employing the forceps not only for the purpose of extraction but more so, as a means of dilatation; and that is by slow delivery with the avoidance, as much as possible, of undue pressure on the fetal head. For this purpose I employ my modification of Kielland forceps, but the standard Kielland model might do as well. In a number of these cases, in order to start dilatation, I have resorted to crushing the unyielding external os with the tip of the finger.

The following condition constitutes another pitfall. On careful vaginal examination the lower edge of the bladder and both ureters as a rule, can be felt forming a horseshoe shape, with the convex upward. At the end of pregnancy and to an even greater degree during labor, this is quite pronounced. On rectal examination they likewise deceptively resemble the external os and simulate a degree of dilatation to that extent. Pressure on any part of this ring, rectally or vaginally, will cause a desire to urinate. It can thus be distinguished from the external and internal os and cervicovaginal junction.

That portion of the membranes originally attached to the internal os, in many cases before rupture, can be felt vaginally as a small dimpled depression with an elevated, ringed border. After delivery of the placenta "one will often find at the free edge of the membranes an imperfectly circular formation of the thickness of 1/16 to 1/8 inch at the largest elevation with tapering ill-defined edges and a lumen varying from 1/6 to 1/4 inch in diameter. Such formation marks the outline and original attachment of the membranes to the internal os."[3]

Helpful Suggestions for Rectal Examination. When the cervix cannot be felt per rectum, pressure above the symphysis in a backward direction will often bring the cervix forward and in line of palpation, if it is extremely retrocessed. As already stated, pressure on the internal os causes a cramp-like pain, generally in the lower

* Since writing this article I have had 2 cases of persistent transverse presentation where a classic cesarean section was done one week prior to the expected onset of labor; in one of these the *x*-ray picture distinctly showed the contraction ring which was irregularly circular without an opening in the center, and about three inches in diameter. In both cases the ring was distinguishable by the thickness and firmness of the lower end of the uterine segment when felt from within, and the inability to insert a drain. Vaginally the cervix was almost effaced without dilatation, and the presenting pole was not palpable.

anterior third of the uterus. The ureters and lower border of the bladder give the patient a sensation of a desire to urinate. The cervicovaginal junction is usually more bulky than the internal os or the bladder-ureter curve, is insensitive to pressure and when rolled under the finger from without inward will flatten and disappear, or become puckered into an elevation when encountering its cervical attachment. Rectally, if the finger is moved from within outward, in a gentle, pushing manner, it will as a rule, not disappear unless a special effort is made to do so. Any of these signs, when present, dictate that the external os is to be sought more centrally. The external os, when the cervix is obliterated, may be of very thin and soft, or of firm consistency, or relatively thick and soft, or firm. When firm, like the folds of the scalp or bundles of hair, it imparts a snapping sensation to the examining finger as it is moved over its edge in a transverse direction, with the distinction that the external os is continuous and more uniformly round than the others. It becomes more pronounced and tense during a uterine contraction if the head descends with it; it is, like the cervicovaginal junction, insensitive to pressure. A short time ago an able resident physician reported a case of full dilatation of the cervix after a rectal examination. A rectal examination done by myself revealed none of the distinguishing landmarks mentioned but a vaginal examination was done in order to determine not how much dilatation there is present but how little, or if there is any dilatation at all. This cervix was found to be dilated only to an extent of one fingertip.

In the absence of contraindications, vaginal examinations followed immediately by rectal ones may be done for comparison. This can also profitably be followed during the last few weeks of pregnancy. Such repeated examinations with the object of acquiring the art will in time educate the examiner's finger to differentiate the fetal presenting pole with or without the intervening cervix or lower uterine segment. It will also recognize caput succedaneum from the rest of the head.

SUMMARY

1. As an aid to determine rectally the amount of cervical dilation, I have shown how to locate and recognize the external os from the other structures which might be mistaken for it.

2. I have also described the ring of cervicovaginal junction and its component parts and the manner of distinguishing it from the external and internal os;

3. The normal and pathological features of the internal os, its association with the undilatable cervix and its differentiation from the external os and cervicovaginal junction and ureter-bladder curve;

4. The ureter-bladder curve, its recognition and differentiation from the internal and external os and and cervicovaginal junction;

5. The various phases of undilatable cervix, their diagnosis and management;

6. The folds of scalp, bundles of hair, possible divisions of the circular fibers of the cervix and their differentiation from the external and internal os;

7. Recognition of the original attachment of the membranes to the internal os;

8. In a general way, the landmarks of the lower uterine segment and its content, their elicitation and evaluation as compared with their respective rectal and vaginal manifestations; and

9. Suggestions for ways to cultivate and acquire the art of rectal examination with the view to facilitate correct obstetrical diagnosis through this channel.

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VENTRAL POSITION FOR DRAINAGE IN RUPTURED APPENDICITIS

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RUPTURED appendicitis is a treacherous disease and events occur rapidly when once pus invades the peritoneal cavity. There is no other place in the body where Nature acts so speedily and with such force, where toxins are absorbed so readily and where great amounts of pus can accumulate so quickly. Therefore, the treatment in these cases should be directed to early evacuation of the pus and detoxification of the patient. It is believed that this can be much more satisfactorily accomplished by the ventral position than by the Fowler position.

In May, 1930, the senior author reported a series of 108 drainage cases with a mortality rate of 12 per cent. In January, 1928, he began using the ventral position and technique routinely as herein described. In October, 1930, he reported 37 cases with a mortality of 2.7 per cent. We have now treated 80 drainage cases with 6 deaths and with a corrected mortality of 3.8 per cent.

Immediate operation through a routine McBurney incision is advocated in practically all cases. The appendix is found and removed with as little manipulation and trauma as possible. When necessary the area around the appendix is coffer-dammed with gauze. The pus is aspirated as it comes into view. Catgut sutures are used throughout. If possible the stump of the appendix is always inverted. The aspirator is then placed along the brim of the pelvis, following the finger as a guide to the bottom of the pelvis. This area is thoroughly aspirated and upon removing the aspirator a cigarette drain, one-half inch in diameter, is placed in the pelvis following the path of the aspirator. A small drain, either of gauze or rubber tubing, is placed at the stump of the appendix. All hemorrhage is controlled and the wound closed loosely about the drains. It is important to anchor the drain and to cut it off even with the skin so that it will not be driven against the pelvic floor when the patient assumes the ventral position.

As indicated in the accompanying cut, the position is simple. It is assumed immediately upon returning the patient to the room. The patient is placed upon the abdomen with the face turned to the left, the left arm is flexed at the elbow, while the right is placed parallel to the body. The left leg is slightly flexed, and the right remains straight. The head of the bed is elevated 8 inches. The patient maintains this position from thirty-six to forty-two hours, depending upon the amount of drainage and severity of the case, but at intervals may be turned on the right side for rest and for catheterization. A pillow placed under the chest but not under the head frequently adds greatly to the comfort of the patient. After thirty-six to forty-two hours the patient is permitted to lie upon the back, but encouraged to spend as much time as possible on the right side.

The reasons for the ventral position are obvious. It places the incision at the lowest point of the abdomen, and the drain keeps an open pathway to the depth of the pelvis, providing actual and immediate drainage. The advantage is obtained also of both intra-abdominal pressure and gravity in drainage and the pus is discharged instead of being pooled in the abdomen, depending upon capillary attraction to remove it.

The average period of illness in this series of cases before operation was 3.3 days. The average leucocyte count was 16,500. Normal temperature was regained in 6.9 days, and the average stay in the hospital was 17.1 days. On discharge there were 4 wounds still draining pus; 19 had healed; in 56 drainage had ceased and the wounds were granulating, and 1 showed delayed healing.

With the use of the ventral position the postoperative course is attended with much less morbidity than the dorsal or Fowler position, and as a rule the abdomen drains thoroughly in twenty-four hours, detoxifying the patient in a very short interval, before severe morbidity has time to occur. For this reason there is a decided decrease in the amount of drainage and sloughing. The patient regains normal temperature earlier, has less gaseous distention of the bowels, fewer dressings are necessitated and better closure of the wound owing to earlier checking of the process of inflammation, with the result that recovery is hastened.

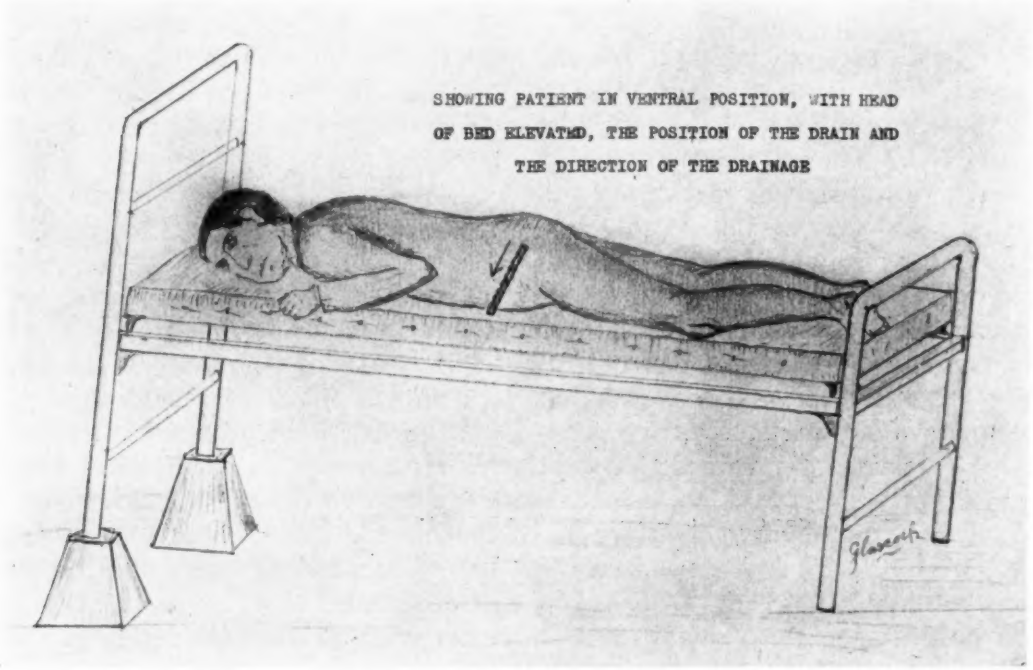
SHOWING PATIENT IN VENTRAL POSITION, WITH HEAD
OF BED ELEVATED, THE POSITION OF THE DRAIN AND
THE DIRECTION OF THE DRAINAGE

FIG. 1.

Included in this series are 3 deaths in which each patient was moribund upon admission to the hospital. These patients were operated hoping that they might receive that one miraculous chance. The first case had been ill four days. Coma was beginning, the pulse was 120 and respiration was 35 per minute. The leucocyte count was 19,800. The entire abdomen was rigid and board-like. This patient died eight hours after operation. The second case was a diabetic woman, sixty-seven years old, who had been ill for three days. Examination revealed a large, pendulous abdomen containing a movable mass in the right lower quadrant, 22 × 14 cm. in size. Her pulse was 105 and respiration 28 per minute. The leucocyte count was 13,200. This patient died thirty-six hours after operation. The third case had been ill six days when he entered the hospital. The temperature was normal, but the leucocyte count was 23,000. The patient was in the first stage of coma and died twelve hours following operation. Inclusive of these cases, the report does not give a true conception of the value of the ventral position and they are only included because they were operated.

Exclusive of the 3 cases mentioned 3 other patients died, 2 from intestinal obstruction and one from what appeared to be a more virulent form of infection than is usually encountered in the ruptured case. Thus in eliminating the 3 moribund cases we have obtained a corrected mortality of 3.8 per cent which is felt represents the true value of the use of the ventral position and indicates that it is an improvement over the Fowler position for drainage.

CONCLUSIONS

The ventral position for drainage in ruptured appendicitis hastens recovery and aids materially in reducing the mortality.

TWO QUANTITATIVE TESTS OF PERIPHERAL VASCULAR OBSTRUCTION*

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IN THE course of treatment of a patient with peripheral vascular obstruction, whether due to thrombo-angitis obliterans or vascular sclerosis, one is frequently faced with the problem of using an accurate criterion for determining the increase in vascularity which might follow any measure of treatment.

Tests and signs previously employed indicate only qualitatively whether or not peripheral vascular obstruction exists. Among these tests may be included, inspection of the extremity, palpation of vessels, intradermal histamine and saline tests, the Buerger test, capillary tests, Lewis-Pickering test, oscillometric index and the Landis skin temperature test. None of these signs offer any information regarding the degree of vascular obstruction, nor can they be used to follow the progression or improvement of vascularity of an extremity under treatment. The only methods available today are the subjective symptoms of the patient and the rate of healing of an ulcer when present.

To meet with this problem we have devised two tests:

1. *Venous Filling Time.* It is obvious that if organic peripheral vascular occlusion exists, there occurs a retardation in the rate of capillary filling after an extremity has been emptied of its blood. This delay necessarily results in a slower filling of the veins. We have utilized this phenomenon for our test in the following way:

The patient is placed in the recumbent position and the foot or the hand is elevated as high as possible. The patient is then instructed to alternately flex and extend the digits till blanching occurs. The extremity is then lowered below the level of the bed and the time is immediately noted. It will be seen that at this time the veins are collapsed. The test consists of noting the time required for the blood to show the first signs of distending the vein.

The normal rate at which venous filling occurs after emptying is seven to ten seconds. In pathological cases we have found the delay in filling time to extend as high as two minutes. Obviously, the longer the filling time, the more profound is the degree of peripheral vascular obstruction. Again, rate of venous filling may adequately be used as an absolute criterion of changes in the volume of blood reaching the veins.

2. *Claudication Time.* The patient is walked over level ground which has been marked off in feet. We have used one side of our hospital grounds which is a straight level sidewalk, 400 feet long.

The optimal rate of walking, which is kept constant in all tests, is 11 paces in five seconds. We have found that this rate strains the walking gait to its capacity and is just short of running. Any attempt to walk the patient more slowly will create a false concept of his walking capacity for his ability to recover will hardly be impaired. In performing the test, the observer, stop watch in hand, walks with the patient and sets the pace. The total distance covered is of little importance to the test because it varies greatly with the stride of the individual. However, the total distance walked is noted for comparative studies in the same patient. We have found that claudication time has been as low as twenty seconds in some patients. Changes in this time have given us an excellent standard for measuring degrees of improvement in the vascular capacity of patients under treatment.

CONCLUSION

Two tests are introduced which possess clinical value in determining the progress of a patient with peripheral vascular obstruction:

(1) Venous filling time and (2) claudication time.

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INTESTINAL OBSTRUCTION*

DIAGNOSIS, BIOCHEMISTRY AND RELATIONSHIP TO THERAPY

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IN view of the high mortality of intestinal obstruction, often quoted as much as 50 per cent, the subject is well worthy of discussion. The phases of etiology, diagnosis, biochemistry and its relationship to therapy will be considered.

A workable classification of obstruction is the following: acute mechanical, acute non-mechanical and chronic obstructions. From the point of view of frequency, acute mechanical obstruction is most often due to postinflammatory or postoperative adhesions and to strangulations of external herniations as inguinal, femoral, umbilical and incisional. Over 75 per cent of the obstructions in children under two years of age are the result of intussusception, usually ileal in location. Neoplasms constitute the fourth most frequent cause, particularly of the rectum and sigmoid. All other forms of intestinal obstruction combined constitute but 15 per cent of the obstructions. These include volvulus (sigmoid, or jejunoileal); internal herniations, which may extend into the abdominal fossa, into the lesser sac or be diaphragmatic; Meckel's diverticulum; and the obstipation of impacted gallstones, food and feces. Also the rare postoperative torsion of the superior mesenteric vessels would fall into this group.

The non-mechanical group may be divided into the adynamic and the spastic types of obstruction. The adynamic type produces the silent abdomen of peritonitis. This may be the result of a ruptured viscus, such as a perforated gastric ulcer; it may be secondary to a leaking pyosalpinx; or it may be the sequella of gangrenous intestine or of hemorrhagic pancreatitis. The functional type of adynamic ileus include spinal cord lesions such as tabes dorsalis, uremia, postoperative, most often following nephrectomy and prostatectomy, and the ileus following retroperitoneal hematoma. The spastic type of adynamic ileus may be the result of a blow to the abdomen, lead poisoning or mesenteric thrombosis or embolis.

Chronic obstructions include neoplasms, adhesions, impactions, Hirschsprung's disease, impactions and strictures. Strictures may be neoplastic, tuberculous, luetic, lymphogranulomatous, or subsequent to the protracted inflammatory process of endameba histolytica infestation.

In the analysis of a case of intestinal obstruction, it is necessary to endeavor to determine its nature, extent, localization and the disturbance in the biochemical equilibrium. The classical signs and symptoms of intestinal obstruction are essentially four: (1) colicky pain, (2) regurgitant vomiting, (3) progressive distention and (4) absolute constipation. One or more of these classical observations may be missing in a given case. I shall consider these symptoms in more detail.

Pain, at first, represents an overactive peristalsis, in an effort to overcome an obstruction. It is colicky and intermittent. With gangrene and peritonitis the pain changes in character and tends to be dull and radiating. In chronic obstruction, such as neoplasm, the pain is often transient and inconsequential.

Vomiting is usually sharp and projectile, with the onset of obstruction. If the obstruction is high, the damming back of gastric and digestive juices results in a regurgitant type of vomiting unaccompanied by nausea. On the other hand, in low obstructions there is absorption of these fluids by the jejunum and ileum and vomiting may be minimal or absent. When the shock syndrome is superimposed, there is congestion of the fine venules of the intestinal tract and consequent capillary diapedesis of albumin and hemoglobin into the lumen. Coffee-ground vomitus produced at this stage, may readily be confused with fecal vomiting which is terminal.

* Read before the Manhattan Medical Society, June 3, 1936.

Distention is progressive when there is complete obstruction. However, in high obstruction there is not much distention. Likewise, in a closed loop obstruction such as a strangulated umbilical hernia, distention may be absent. In large intestinal obstruction, distention may be very prominent because of the marked distensibility of the large intestine. On the other hand, Sperling[1] has recently called attention to the valve-like effect of the ileocecal sphincter which allows small bowel contents to pass into the colon but impedes regurgitation. If there is sufficient pressure against the valve, gangrene and hemorrhagic necrosis of the cecum may occur without generalized abdominal distention.

An understanding of distention entails a consideration of intestinal gas and a slight digression will be made to study the source of gas.[2] They are essentially three: (1) air that has been swallowed; (2) air that has diffused through the intestinal wall and (3) gas that has formed by chemical changes in intra-intestinal matter by the action of gas-producing organisms.

Interference with the venous return, such as is found in sudden volvulus, retards the absorption of gas. When the distention reaches a high grade, there is a compression of the capillaries of the intestinal wall and there is also an increased intraperitoneal pressure, each of which markedly embarrasses venous return. This accompanied by capillary damage causes an outpouring of fluid into the lumen. The gas formed consists mostly of the inert nitrogen and partly of diffusible CO_2. There is very little oxygen present. As the circulation becomes ineffective, the lack of oxygen contributes further to capillary atony. With the slowing of the blood stream and with the slowing of peristalsis, the rate at which blood can carry away gas is further decreased.

The problem of obstipation is an important one. There are patients with complete obstruction who spontaneously defecate. Wangensteen has shown in dogs that a bowel may evacuate itself below a complete obstruction. In a similar instance, in complete obstruction there may be a return from an enema. With gangrene of the gut and with intussusception, bloody diarrhea may develop. The evaluation of complete obstruction is well put by Amendola,[3] to quote: "If feces and gas are obtained but symptoms of distention, pain, vomiting, are not relieved, obstruction is probably complete." The most effective means of determining if obstruction is complete is by giving mineral oil by mouth, one ounce every hour and observing if oil drops are present in the Harris drip enema can. Both inflow and outflow tubes are left in the rectum during the entire period of observation, and by raising and lowering the can, the colon is irrigated and the contents can be examined for the presence of oil showing that obstruction is not complete. No vaseline or oil should lubricate the tubes as this may produce oil drops in the can.

In an endeavor to reach a more exact diagnosis as to the type of a complete obstruction, clinical evaluation is most important. Laboratory aids including *x*-ray studies are of additional assistance. Careful examination of hernial rings, particularly the femoral, rectal examination, examination of postoperative scars and careful analysis of findings suggestive of neoplasm (anemia, loss of weight, alternating constipation and diarrhea) will ascertain over 75 per cent of the causes of intestinal obstruction. Signs of other congenital anomalies such as polydactylism, might suggest a Meckel's diverticulum which acts essentially like an adhesion in producing obstruction. Venereal infection, buboes, tuberculosis, perineal lacerations during delivery, all suggest stricture. With visceroptotic individuals volvulus should be suspected. Evidence of heart disease or embolic phenomena suggest mesenteric artery thrombosis while septic abdominal processes and cirrhosis of the liver suggest mesenteric vein thrombosis. A history of previous attacks of salpingitis, appendicitis or cholecystitis suggest the site of intestinal obstruction. A history of a preceding common duct obstruction brings to mind the possibility of obstruction from gallstones.

Recently, considerable study has been given to *x*-ray plates of the abdomen in intestinal obstruction. Plates are taken in three positions: (1) with the patient lying on the stomach, the rays being shot from the back. This position throws the small intestine in close proximity to the *x*-ray plate and is the best view for observing small intestine dilatation. The weight of the patient throws some loops of small intestine laterally which should not be interpreted as large intestine. A characteristic step ladder arrangement is often noted as the result of the superimposing of loops of small intestine. (2) With the patient lying on the back, the rays being shot in from in front, the sigmoid and large intestine may best be observed. (3) The upright and lateral positions reveal characteristic fluid levels when these are present. Ausculation of the abdomen would reveal a succussion splash because of air overlying fluid.

In *x*-ray interpretation, the problem resolves itself into determining if fluid levels are present; if small intestine, large intestine or both are dilated; and determining the possible site of obstruction. Small intestine is determined by location, its homogeneous appearance, and the relatively narrow valvulae conniventes. Large intestine is recognized by its lateral position, mottled appearance and the wide haustrations. It is important that no enema is given prior to *x*-ray examination, otherwise distended large intestine may be observed. When obstruction is protracted, the *x*-ray plates may be deceiving, as atony of the intestinal musculature distal to the obstruction may appear as dilated intestine. Perforated or gangrenous intestine will result in peritonitis causing dilatation of large as well as small intestine. Thus a paralytic ileus has been superimposed on an acute mechanical obstruction.

The value of blood counts in determining the onset of gangrene of the intestine is of doubtful value. Amendola,[3] in an analysis of 241 cases of intestinal obstruction finds that temperature and leucocytosis are not of aid in this respect. Leucocytosis and absence of leucocytosis have been found in intestinal obstruction with and without gangrenous intestine. However, generally, peritonitis is reflected by a shift to the left when a careful Schilling index is done, that is, the appearance of band forms and two lobed transitional polymorphonuclear white blood cells. Intestinal obstruction due to the rare lymphosarcoma of the intestine may be suspected by changes in the peripheral blood.

Blood chemistry studies are most significant from the point of view of therapy. Protracted vomiting results in a definite alkalosis. The starvation associated with vomiting causes ketosis because of the poor combustion of fats. Diminution in blood chlorides occurs even in the absence of vomiting. This diminution in chlorides is accentuated when the shock syndrome supervenes. A rise in non-protein nitrogen, particularly urea, occurs because of the diminished circulatory volume with a decreased urine output and because of the increased destruction of protein. There is also a rise in the non-protein nitrogen in proportion to the decrease in chlorides. This phenomena of a rise in urea with the appearance of low chlorides, in spite of a good urine output, was demonstrated by Harrop and Loeb. They found that during the diuresis of a crisis of Addison's disease, there was a rise in the non-protein nitrogen as the chlorides fell.

The presence of a decreased blood chloride and a high non-protein nitrogen or urea in intestinal obstruction is in contrast with the ileus associated with transient renal insufficiency as described by Wakefield, Mayo and Bargen.[4] In this syndrome, which is usually found in hypertensive arteriosclerotic individuals with diminished kidney function, there is a normal or high concentration of chlorides and a high non-protein nitrogen. The ileus that the patient with this syndrome presents may be clinically indistinguishable from a true mechanical intestinal obstruction.

The basal metabolic rate is often increased because of the failing circulation and increased CO_2 concentration of the blood, and because of the abnormal destruc-

tion of protein. A powerful toxin is formed from the broken down intestinal mucosa. This was investigated by Bernheim, Stone, and Whipple.[5] When this toxin is injected intravenously into normal animals, it produces shock.

Aird[6] found an unexpected fall in blood pressure on the relief of an intestinal obstruction in dogs of six to eighteen hours duration. This strongly suggests the diffusion of a depressor substance, particularly when the obstruction is removed.

In intestinal obstruction death appears to be the result of a combination of several factors: (1) loss of body fluids with the subsequent shock syndrome;[7] (2) disturbances of acid base balance; (3) toxemia; (4) perforation and peritonitis.

The relationship of treatment to this discussion is apparent. Preoperative infusion of saline and glucose should always be given. It is advisable to insert a canula into the vein at this time so that subsequent intravenous treatment will be facilitated. Operation, when there is mechanical obstruction should be done, if possible under spinal anesthesia. When the shock syndrome is present, spinal anesthesia is contraindicated and local infiltration or ether should be used; in the latter case, particular care should be exerted to avoid aspiration of gastric contents. Thorough gastric lavage before operation is always indicated. During the operative procedure an effort should be made to relieve the obstruction with a minimum amount of trauma, thus minimizing shock. It is advisable to look immediately for collapsed bowel and follow that to the point or points of obstruction. The direction of investigation may be ascertained by the fact that the jejunum is thicker and has more marked valvulae conniventes while the ileum has more fat and marked arterial arches. With the freeing of the obstruction and the consequent liberation of depressor substances, compatible whole blood should be poured into the infusion set which furnishes a slow intravenous drip during the operation. Upon completion of the operation, CO_2 and O_2 inhalation and coramine intravenously may be given.

When the patient is returned to the ward, the following should be provided:

1. Adequate decompression by gastric lavage or Wangensteen apparatus; later this may be replaced by a simple duodenal tube; rectal tube to be inserted and left in situ;

2. Oxygen by nasal catheter. This favors capillary tone thus minimizing shock; and it also favors gaseous absorption;

3. Continuous infusion of saline and glucose, charting fluid intake and output; also gauging amount of fluids required by frequent specific gravity determinations of urine and by frequent red cell counts of blood, as well as by the usual clinical observations;

4. Antigas gangrene serum to be given to minimize the effects of toxins produced by gas forming organisms in the stagnant bowel;

5. Pitressin intramuscularly to promote peristalsis; later ox bile enemas may be used as well as magnesium sulphate by mouth.

SUMMARY

In the paper presented an effort has been made to consider a workable classification of intestinal obstruction, the more common causes being emphasized. The cardinal symptomatology and its variations were discussed in detail. The mechanism of gas and fluid production in the intestinal tract were outlined. A practical method of determining if obstruction is complete was offered. A correlation of clinical, laboratory and *x*-ray findings were presented. Altered blood chemistry findings were considered from the point of view of physiology, differential diagnosis and therapy. The logical management of acute mechanical intestinal obstruction was delineated.

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CASE REPORTS

SURGICAL TREATMENT OF TRANSCAPSULAR RUPTURE OF KIDNEY

FOUR CASES

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TRAUMATIC rupture of the kidney was first described by Galen[40] in 1561. The description of Rayer,[41] in 1839, remains a classic. Its occurrence in modern civilization has been variously estimated from 1 in every 1000,[2,3] to 1 in every 3000[4] injuries.

Six ruptured kidneys were admitted to the Freedmen's Hospital, a 300 bed unit, during the first seven months of this fiscal year, 5 being complete ruptures, 4 of which were caused by gunshot wounds, and one a subparietal type. Because a severe kidney rupture was not seen for ten years of service in the Urologic Department, the author was amazed at this avalanche of cases and sought enlightenment from the literature.

This study revealed that in the "horse and buggy" days, it was not uncommon to be struck by a falling object,[11] run over by a cart wheel,[12–14] kicked by a mule,[13] thrown from a horse,[16–17] or to fall[10,11,21,22] and receive a severely ruptured kidney, walk miles to reach home or some institution, and in either case, to succumb from hemorrhage or infection. Medical meetings were studded with reports and demonstrations of specimens of fatal ruptures due to severe or trivial trauma.

No progress was made until the courageous work of Bremdt,[17] in 1873, in Vienna. His successful removal of a stabbed kidney on the fourth day seemed to awaken the medical world to surgical consciousness. Four years later his surgery followed closely the first premeditated removal of a kidney by Gustave Simon.[15] Czerney's[15] conservative repair of the kidney parenchyma done with five catgut sutures in 1887, initiated a significant era in conservative kidney surgery.

The modern attitude toward a ruptured kidney is conservative. Keen judgment, as to what to do and when, is the primary requisite,[20] for when radical procedures are necessary, they must be conservative.[23,24] This insight cannot be acquired by experience with ruptured kidneys, for the rarity of their incidence in the hands of any one surgeon is established.

The literature on the subject is so voluminous that approximately 1300 cases have been recorded. In spite of this, however, there appears to be a need for a more definite and precise formula which may guide the proper course of treatment as there has been too much uncertainty in the management of cases of this type.[23]

Heterogeneous mortality statistics collected by various authors leave little choice between expectant treatment and surgery.[1,2,3] However, statistics compiled from series which have been analyzed eliminating severe associated injuries, which in all probability caused the mortality,[25] show a marked improvement in rate when they are handled with that keen surgical judgment which "shuffles and deals" the expectant, the immediate and delayed operations, and the conservative and radi-

cal procedures according to the patient's requirement.

The presentation of the 4 cases represents the author's entire experience with transcapsular kidney rupture requiring surgery.

The following 2 cases, classified as subparietal transcapsular rupture, are presented.

Case 1. W. J., a sixteen year old Negro lad, was admitted to the Urologic Service about 6:00 o'clock P.M., September 16, 1932. About noon, the preceding day, the bicycle which he was riding crashed into a tree and threw him forward against the handle bars which struck him in the left side about the eighth to tenth ribs in the midclavicular line. He remained conscious and walked home in agonizing pain. He voided bloody urine after the injury but catheterization was necessary. On examination, he was lying in bed splinting his left side. There were lacerations over the left anterior chest wall from the eighth to tenth ribs and a swelling of the upper lip. Tenderness and rigidity of the left flank and abdomen were present and a tympanitic note was elicited over the entire, slightly distended, abdomen. Neither kidney was palpable nor was a mass noted in the left flank. The temperature was 101.6°; pulse 120; respiration 28; blood pressure 175/105; red blood cells 4,370,000; hemoglobin 80 per cent; white blood cells 9,700.

The original impression was rupture of the left kidney and possibly injury to the abdominal viscera. A surgical consultation agreed with the urologic opinion and concurred in the expectant form of treatment.

The first fifteen days were characterized by a gradual decline of the pulse rate, a low grade remittent fever, continuous, unabated hematuria, and a persistent, painful, tender and rigid left flank. No mass was palpated. The patient's general condition remained below normal. His blood pressure was 138/68.

The second fifteen day period began with marked dysuria followed by increased hematuria. Blood clots collected in the bladder causing acute retention on the seventeenth day. The pulse became more rapid, pain in the left kidney region continued, the red blood cells were reduced to 3,200,000, hemoglobin to 60 per cent, blood pressure 122/72. His general condition was weaker. Intravenous skiagram study on the eighteenth day showed (1) nonfilling of the upper calyx on the left; (2) dilated ureters, up to 1 cm. in diameter, particularly on the left throughout its entire extent; and (3) the bladder distended with a blood clot. The impression was that the left kidney was probably ruptured at the upper pole causing accumulation of blood in the bladder which had obstructed the orifice causing the ureteral dilatation.

After repeated catheterization, free voluntary passage of smoky urine with some small dark clots was noted on the twenty-second day. The general condition seemed stabilized at a very low ebb. The urine was clearing, though dysuria and severe abdominal pains continued to be an aggravating feature. On the twenty-eight day there was an abrupt recurrence of hematuria and suprapubic pain was observed as a new feature. The red blood cells were found to be 3,000,000. A general consultation among the urological and surgical staffs agreed to surgical intervention for the following reasons: (1) a severe rupture of the left kidney was present; (2) expectant treatment of one month had produced no satisfactory results; (3) the patient's life would be in danger if recurrences of bleeding continued; and (4) it is wise surgery to intervene before it is too late.

At operation a nephrectomy was done as the left kidney was severely lacerated at its upper pole, half of which was destroyed completely; the other half showed signs of organization.

The convalescence was punctuated by a mild bronchopneumonia. Before discharge on the twenty-ninth postoperative day, a phenolsulphonphthalein showed 45 per cent output in the first half hour by intravenous method. His recovery was complete.

This patient when seen recently, after four years, shows normal development in every respect.

Case 11. As the result of a fall from a runaway horse, R. F., a male Negro of fourteen years of age, was admitted on July 18, 1935, about 10:00 o'clock P.M., complaining of a "pain in his left side and of passing blood instead of water." At the time of the accident, which occurred about 6:30 o'clock P.M., July 18, his employer, noticing that simple medication was of no avail, brought him for admission. When first observed, he was unable to take a deep breath without intense pain in the left side; he was in bed with flexed knees to

ease the pain in the left anterior lumbar region; he was noticeably drowsy and responded reluctantly to questioning. The family history was negative.

The significant findings on physical examination were, (1) a definite splinting of the muscles of the left side; (2) tenderness over the left epigastric and lumbar regions anteriorly and the left kidney posteriorly; (3) above the left iliac crest a mass was outlined with difficulty through the splinted muscles; (4) blood pressure 108/78; pulse 88; temperature 98; (5) vomiting of small amounts of green material and mucus; (6) urine very bloody; (7) hemoglobin 85; red blood cells 4,190,000; white blood cells 13,850; (8) within an hour, the pulse had increased to 108; respiration 24; temperature 99; and at that time, there was no abdominal distension.

On the morning following admission, with an average temperature of 99.6, pulse 104, bloody urine, he felt somewhat relieved of pain. On the second day following admission the drowsiness persisted and his general condition remained unchanged except for increased rigidity of the left abdominal muscles, associated with more tenderness and local pain. Meteorism was a new symptom. The mass in the left loin appeared increased in size.

A repetition of white blood cells showed 11,800, and hemoglobin 75 per cent At this time an intravenous skiagram series showed that the left kidney was ruptured through its middle. With the general restlessness and pain prevailing, hematuria continuing unabated, an increased pulse rate to 128, some diaphoresis and progressive loss of ground, operative interference was deemed advisable.

At operation, under general anesthesia, there were hematomas of the transversalis and psoas muscles which were fixed by an exudate to the perinephritic capsule. On opening the fatty capsule, there were approximately thirty ounces of blood clots. The left kidney was found to be ruptured at the junction of the lower and middle thirds through the entire substance of the organ.

A total nephrectomy was performed and two cigarette drains were inserted. Supportive treatment for the operative shock was instituted.

The postoperative course was uneventful. He was discharged as cured on the twentieth day after admission.

COMMENT

The injury in each case was due to direct trauma over the kidney region. An analysis of the symptoms common in kidney rupture and present in these cases is recorded as follows:

1. Shock was absent in both cases.

2. Pain was present. It bears no direct relation to the extent of the parenchymal tear and is caused by distention of the pelvis.[1]

3. Hematuria was immediate in these cases as in upward of 95 per cent of all cases.[5,20]

4. Rigidity and splinting of the muscles of the injured side of the abdomen and loin were present.

5. Tympanites, present in each, is known as renal ileus,[25] sometimes called a reflex phenomenon, but actually it is caused by an irritation of the posterior parietal peritoneal wall.[7,29] Vomiting in Case II was stimulated by the same irritation.[18]

6. Neither elevation of temperature nor leukocytosis alone or together is characteristic of infection[7] because the absorption of blood clots and extravasated urine is associated with these reactions.

7. Outline of the mass, usually a hematoma, is often difficult because of the tenderness which limits palpation. In Case II it was observed to increase in size, whereas it was not elicited in Case I. The mass may be extravasated urine which becomes either infected or encysted, or, in smaller amounts may be absorbed. The course of the mass, whether urine or blood, is along the psoas muscle to the inguinal region or base of the penis.[6]

Complete urologic study including direct urography, with the presentation of data to substantiate its rationale, has been advocated as a logical procedure.[7,8,18] Intravenous urographic study, invariably negative in shock,[4] was reasonably effective in both of the cases presented as the pathology was minimally pictured. A direct urographic medium would have flowed from the superior pole into the

surrounding tissue in Case I, whereas, in Case II, it would have reached the perirenal region through the transversely sectioned kidney. This would have hastened surgical intervention in Case I. Case II was operated immediately, notwithstanding. The choice of the two procedures is a matter for the judgment of the urologist. Advocates of direct urographic study are increasing.

Case I presents a genuine effort directed toward conservative expectant treatment, but was directed toward surgery at the crucial moment. Surgery here was probably too radical, yet was dictated by the extent of anemia and general debility which warned against infection.[20] Mechanically, a resection of the upper pole was possible but it was thought to be unwise. In Case II, there was no alternative for nephrectomy. In the surgery of ruptured kidney, conservatism[2] is the rule; severe hemorrhage and late infection being the only indications for nephrectomy. Routine nephrectomy is wrong[1] for one may be astonished at the reparative ability[1,7] of a damaged kidney, as well as the return to normal physiological output.

Gunshot wounds of the kidney very rarely are reported in military life; 129 among 170,481 battle casualties in the World War,[20] not to speak of civilian life. In combination with other visceral injuries, they occasionally dart the literature.

The most comprehensive study of gunshot wounds of the kidney appears in the reports of army surgeons, although several reports in civilian centers contribute wealthily to the literature.[9,24,28] Records of the Civil War reported by Judkins,[27] showed only one of 3 cases of ruptured kidney to be due to a shell. Gunshot wounds of the recent World War have been reported and analyzed critically.

The following significant data on intraperitoneal wounds in relation to the kidney are recorded:

1. In Germany, Laewen found that 37 of 42 cases of gunshot wounds of the kidney involved the peritoneum. Of a total of 57 cases collected from the German war records, only 5 recovered.[30]

2. The British found that 155 cases, or 7.3 per cent, of gunshot wounds of the abdomen involved the kidney, with a resulting mortality of 36.8 per cent.[28]

3. The French found a much smaller percentage of kidney injuries associated with intra-abdominal wounds.[31]

4. Among the American Expeditionary Forces, 66 cases were found in the records of the Medical Department of the United States Army which presented gunshot wounds of the abdomen.[26] A mortality of 50 per cent resulted.

Gunshot wounds of the kidney in civilian life should offer a much better prognosis than that of the army in the field. The civilian is in vastly better general physical condition than the soldier, worn by battle, hardship and exposure, and, furthermore, the advantage of complete urologic study and timely operative intervention is available in civil life.[9,26]

To serve the following similar cases within the short period of five months is an unique experience.

Case III. J. W., a well developed Negro of twenty-six years of age, was admitted to the surgical service in profound shock at 11:30 o'clock P.M., September 15, 1935, shortly after he had been shot from behind by a bullet which passed through his body. His complaint of "pain in the chest when talking," and definite alcoholism, made a good history impossible. Examination showed that the bullet entered the back two inches from the midline in the tenth interspace and made its exit anteriorly in the eighth interspace on the right midclavicular line. There was rigidity of the muscles of the right flank and throughout the abdomen. There was such tenderness on the slightest pressure that the presence of a mass could not be determined but a dull note on percussion was noted in this region. The pulse was weak and thready at 60 per minute. The blood pressure was 74/0. His brow was cold and bathed in beads of perspiration.

Shock was combated by hypodermoclysis and stimulants. By morning, the blood pressure was 90/70; temperature 98.2; pulse 96; the red blood cells 3,600,000; white blood cells 6000; hemoglobin 65 per cent. Catheterization yielded frank hematuria. Vomiting from the alcoholic indulgence was noted during the early

morning. When the surgical and urological departments conferred, these conclusions warranted immediate surgical intervention: (1) the path of bullet seemed to be through the kidney and liver; (2) there was definite indication that the fluid in the abdomen was blood for the dull area had extended during the night; (3) the frank hematuria should be localized from the right kidney by cystoscopy and the presence and function of the left kidney could be ascertained.

Under nitrous oxide and ether anesthesia preoperative cystoscopy revealed blood was being ejected from the right ureter and clear urine from the left. No estimate of function was attempted.

Through a right rectus incision about 1000 c.c. of clots and free blood were removed from the right iliac fossa and the pelvis. On the postero-lateral surface of the liver was a freely bleeding stellate puncture. Two mattress sutures in the capsule controlled the hemorrhage completely. The "other" wound in the liver was not located. There was marked discoloration of the posterior parietal peritoneal wall in the region of the right kidney. The peritoneum was closed without drainage and the wound was extended laterally under the twelfth rib. Upon exposure of the fatty renal capsule, a large collection of blood clots came into view, having dissected away the true capsule of the kidney, which, when freed, was found to be shattered in its upper half, much like a crushed nut. Primary repair of the kidney could not be effected so it was placed in a basket of catgut. The wounds were closed and adequately drained, but healed largely by granulation because they broke down almost completely.

Convalescence was uneventful except for a period of postoperative shock. Before he was discharged, forty days after admission, a cystoscopic note of intravenous indigocarmine revealed a two minute appearance time from the injured kidney.

Case iv. G. M., a stockily built Negro, thirty-five years of age, arrived at the hospital by means of taxicab, immediately after he had been shot in the back at 11:00 o'clock p.m., February 7, 1936. There was some evidence of shock although the patient walked to and from the taxi. He complained of sharp severe pains in the hypochondriac and epigastric regions, which became increasingly aggravating. The wound of entrance was located four inches to the right of the midline in the back at the level of the transverse process of the twelfth thoracic vertebra. Anteriorly on the same side the bullet could be palpated at a point four inches from the midline in the tenth interspace just below the skin. There was marked rigidity and tenderness over the right flank and entire abdomen. Percussion revealed a dull note in this area. Upon catheterization bright red blood was obtained. Temperature 94°; pulse 60; respiration 30; blood pressure 110/82. Notation of the blood pressure later in the course of the examination revealed a drop to 90/68. His entire body was wet from a profuse perspiration.

An immediate consultation with the surgical department revealed unanimity of opinion as (1) penetrating wound of the right kidney and liver with profuse abdominal bleeding and (2) immediate exploration of both abdomen and kidney region.

Two hours after the wound was inflicted the operation began via a right rectus incision into the peritoneal cavity where a gush of fresh blood was emitted from a rent in the postero-lateral aspect of the liver. This huge gap could not be sutured and the bleeding was stopped only by packing about 5 yards of gauze into it. More than 1500 c.c. of free and clotted blood were aspirated from the right iliac fossa and the pelvis. The rent in the postero-parietal peritoneum was sutured. In this position, it was clear that considerable retroperitoneal hemorrhage was present in this region. The peritoneum was sutured and drained with the packing coming from the lower angle. The incision was extended laterally under the twelfth rib to expose the kidney area. There were handsful of blood clots removed from this region before the kidney could be exposed. The lower pole not only had been shattered and the pelvis penetrated, but a section about one inch cubed was removed completely, exposing the lower calyx. Considerable free bleeding was noted.

Nephrectomy was accomplished, drainage tubes placed and entire wound closed. Phleboclysis and hypodermoclysis of about 3000 c.c. of 5 per cent glucose were instituted during and following the operation. The packing was removed entirely in thirty-six hours. Healing was by primary intention and recovery was uneventful.

The patient was discharged twenty-four days after operation.

COMMENT

Each case was shot from behind at close range at about 11 o'clock P.M. Guided by the entrance and exit of each bullet, passage through the kidney and liver only was reasonably outlined.

ANALYSIS OF SYMPTOMS

1. Pain and tenderness were noted in each case.

2. The shock which was evident in each of these cases was characterized by subnormal temperature, slow pulse of 60 per minute and lowered blood pressure. The patients' bodies were bathed in perspiration. This type of shock, ascribed to solar plexus injury,[1] is probably a "'histamine' traumatic shock."[44,45] It is easily differentiated from shock due to hemorrhage which is characterized by rapid pulse and respiration associated with anxiety, loss of hemoglobin and red blood cells. The shock noticed in the cases presented, responds well to hypodermoclysis and adrenalin. Treatment of the shock *first* is universally accepted.

3. Hematuria was observed on catheterization in each case.

4. Rigidity of the muscles of the entire abdomen and loin was common to each.

5. An advancing dull percussion note denoted the presence of blood in the abdominal cavity in both cases.

6. Vomiting was present in Case III only. This has been recognized as a positive symptom of abdominal visceral rupture, and usually occurs within five hours.[28] It is to be noted that Case IV was operated within two hours of the injury.

The operative approach differed from that recommended in the Manual of the United States Army Medical Service and others.[28] The first incision, which was made over the lateral border of the right rectus muscle, permitted the best exposure of the liver with simultaneous exposure of the other abdominal viscera and palpation of the left kidney. Subsequent extension of the wound laterally under the twelfth rib, after peritoneal closure, permitted adequate exposure of the right kidney fossa extraperitoneally. As in subparietal rupture, conservative repair of the kidney damaged in less than one-third of its extent is mandatory, except where the time consumed in such repair endangers the life of the patient.[26] Those who advocate exposure of the kidney first in cases of intra-abdominal wounds involving the kidney, feel that (1) less shock is attended in changing from the kidney to the laparotomy position, than from the reverse order,[26] and (2) if there is injury to the hollow viscera, contamination of this material into the kidney fossa initiates a vicious infection.[28] All condemn transperitoneal nephrectomy.

Urologic study is indicated in so far as it is practicable. Catheterization must be done immediately if the patient cannot void. At least the presence of the other kidney must be ascertained, even if study of its function and general condition is not practicable. The more complete the urologic study, the more accurate the opinion.

SUMMARY

1. Treatment of a severely ruptured kidney became rational only after surgery of the organ was generally practiced.

2. Although transcapsular rupture of the kidney is not uncommon, few surgeons are called to handle a large series of cases; yet any surgeon may treat a case.

3. The common symptoms are shock, pain, hematuria, muscular rigidity, tympanites, nausea, vomiting and hematoma.

4. Shock is of two types. The immediate is a dilatation of the vascular bed associated with slow pulse, lowered blood pressure, diaphoresis and subnormal temperature. It is relieved by adrenalin hypodermically and hypodermoclysis of normal saline. Delayed shock is usually due to hemorrhage and it yields best to blood transfusion.

5. Four cases of transcapsular rupture of the kidney are presented, 2 of the subparietal type, and 2 gunshot wounds involving the peritoneum and liver.

6. Urography, direct or intravenous, is indicated where practicable. Intravenous urography was employed in the 2 subparietal cases with satisfactory results.

7. Treatment of transcapsular rupture of the kidney is: (a) expectant, and (b) surgical, as repair and removal.

8. Surgical treatment was instituted in each case, resulting in nephrectomy in 3 cases and repair in one, with complete recovery in all.

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LOBECTOMY FOR CENTRAL ABSCESS OF LOBE; HINGE FLAP FOR MULTIPLE BRONCHOPLEURAL FISTULAS; POST-TONSILLECTOMY PERIPHERAL LUNG ABSCESS

REPORT OF 3 CASES*

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CASE 1. LOBECTOMY FOR CENTRAL ABSCESS OF LOBE

L. U., a girl of eight years, was admitted to the Childrens Medical Service, Bellevue Hospital, August 24, 1934. Her history states she had always been a healthy child until May 1, 1934, when she was admitted to the Polyclinic Hospital for a tonsillectomy, which was done under general anesthesia. Three weeks later, after recovering from the tonsillectomy, which was reported to have been normal, she developed a severe productive cough, ran a septic type of temperature, and expectorated malodorous pus, blood and corruption. Gradually her temperature subsided and she was admitted to the Seaside Hospital on June 16, 1934, at which time, chest examination showed dullness, diminished breath sounds and bronchophony at the base of the right lung. Her Mantoux (1–1000 dilution) was strongly positive. Roentgenograms showed an area 2×2.5 cm. of diminished illumination in the right lower lobe with a small area of rarefaction in its center. Five weeks later this area became less distinct and no cavity could be observed, but on the forty-third day she coughed up blood. Her sputum was reported negative for tuberculous and Vincent's organisms.

On admission to Bellevue Hospital, August 24, 1934, she was well nourished and did not look sick, but coughed occasionally and, at times, raised blood. There was practically no sputum or any odor to her breath. The breath sounds at the right base posteriorly were slightly diminished, while the breath sounds over the entire right posterior chest were increased. She had a low fever most of the time and the aerobic culture of the throat revealed a gram negative Staphylococcus aureus and a diphtheroid bacillus. The anaerobic culture revealed a gram negative micrococci and fusiform bacilli.

The patient remained on the Medical Service one hundred forty-seven days. During this period she coughed very little, raised practically no pus but had repeated hemorrhages ranging from just a mouthful of blood to a severe hemorrhage of several ounces. Postural drainage was non-productive. She was kept in bed continuously and part of the time had a shot bag on her right chest to limit the respiratory movements. Her temperature was of a low septic type, the pulse very fast. Hemoptysis was an almost daily occurrence. The red blood count remained practically normal, while the white cells were continuously elevated, about 12,000. During this period the parietal pleura had become markedly thickened, which obliterated any lung detail in the roentgenograms. However, a lower lobe consolidation, with cavitation, was repeatedly shown.

On January 18, 1935, she was transferred to the Children's Surgical Service. Her weight was fifty-four pounds, a loss of six pounds, and her temperature ranged from 100 to 102°F. She seemed a good operative risk except for her rapid pulse. Several transfusions of small amounts of blood were given which neither increased nor prevented hemoptysis. She was operated for lobectomy on January 28, 1935.

Operation. A long, general utility incision was made in the sixth intercostal space, running from the posterior angle of the rib to the costochondral junction. The sixth and seventh ribs were divided at either end of the incision and allowed to telescope. The parietal pleura was markedly thickened, but there were no adhesions to the parietal pleura and none obliterating the main interlobar fissure. This fissure,

* Read before a meeting of the New York Surgical Society, October 9, 1935, New York Academy of Medicine.

however, did not completely divide the lower from the middle lobe.

When the chest was opened the middle and upper lobes partially collapsed and remained so during the entire operation. The lower lobe was shrunken, hard to palpation, contained but little air, and did not fluctuate. The mediastinum was stable, making only small respiratory excursions.

Between clamps, the lower lobe was divided from the middle lobe, thus completing the main interlobar fissure. The pulmonary ligament was then divided and ligated. A Shenstone snare tourniquet was applied to the pedicle of the lower lobe, the lobe was cut away and the stump closed with a running stitch of chromic gut. Although there was no bleeding when the tourniquet was removed, due to the friability of the peribronchial tissue with which the pedicle stump was closed, a mass ligature was also tied about the pedicle. The middle lobe was then placed over the stump and held in that position by two stitches. A long drainage tube was introduced through the eighth interspace in an airtight fashion. The thoracic cage was closed with several pericostal chromic gut sutures and one pericostal suture of heavy German silver wire. The muscles and fascia were closed in layers. The skin was not sutured.

Pathologic Report. (Dr. Hutcheson.) The specimen consists of the entire lobe of the right lung, measuring 10 × 8 × 6 cm. The pleura over the entire lung is thin, smooth and shiny except over the posterior surface, which is thick and fibrous. The lung tissue is firm, resilient, non-crepitant and does not float in water. Its cut surfaces are firm, gray in color, and studded with several abscess cavities, some of which are partially or completely filled with a granular debris. The largest abscess, 3 cm. in diameter, is located in the central portion of the lobe just lateral to the hilum and a medium sized vessel crosses this cavity in its greatest diameter. Sections show a distorted pulmonary tissue with extensive fibrosis and a diffuse infiltration of polymorphonuclears, monocytes and lymphocytes. The small bronchi are filled with pus and serum. Some of the bronchi are lined by stratified squamous epithelium.

Diagnosis. Pulmonary fibrosis, interstitial pneumonia, bronchiectasis and abscess.

Discussion of Operation. As we were operating for lung abscess of the lower lobe, where some soiling of the pleura was almost inevitable, and there being no pleural adhesions between the parietal and visceral pleura of the upper lobe, the two stage procedure was the operation of choice. However, considering that this patient had been having frequent hemorrhages from this lobe, and that the last one had been very severe, we feared a fatal interstage hemorrhage more than the almost certain pleural infection. For these reasons, a one stage operation was performed. The patient was given gas and ether anesthesia in a closed mask, with very slight pressure. The operative time was forty-five minutes. Blood transfusion at the termination of the operation was not necessary, and the patient was returned to the ward in excellent condition.

Hemoptysis was permanently stopped. The distal end of the drainage tube was placed below the surface of water in a drainage receptacle. There was a drainage of 300 c.c. of serosanguinous fluid in the first twenty-four hours. During the two succeeding days, this gradually decreased. On the fourth day the drainage had become slightly purulent. Superficial inspection of the wound revealed it had healed per primam, but the surrounding area was indurated. On opening the wound, a malodorous, necrotizing, gas bubbling infection was found. Anaerobic cultures were made but unfortunately no growth was reported. Clinically, however, it was a typical Bacillus Welchi infection.

Through the courtesy of Dr. Frank Meleney, we had had some experience in the treatment of necrotizing wounds with zinc peroxide. So, at the suggestion of Dr. Carl Burdick, this powder was used on this chest wall infection. Because a few of the intercostal bundles had been completely dissolved by the rabid infection, some of the suspension was allowed to enter the pleural cavity and permitted to remain until the following day, when it was removed by irrigation with sterile water and more of the suspension instilled. Fortunately, no bronchial fistula developed and it was possible to irrigate the pleural cavity. A suspension of zinc peroxide was placed in every little crevice of the wound with a syringe and the entire wound was packed with gauze which had been impregnated with zinc peroxide suspension. The packed wound was carefully sealed with wide strips of well saturated vase-

line gauze, over which ordinary gauze dressing was placed.

Within twenty-four hours the improvement was spectacular. The slimy slough had begun to vanish and small islands of granulation could be seen. At the end of ninety-six hours there was a clean, easily bleeding, granulating wound and all fear of putrefactive infection of the wound had disappeared.

Barring the wound infection and a small pneumonic process of the contralateral lung, the patient's convalescence has been progressive, and apparently she is cured of her lung abscess.

DISCUSSION. Dr. Frank B. Berry, New York, cited 2 cases with an abscess of the lung that hemorrhaged so continuously that lobectomy appeared to offer the only chance of cure. Both patients withstood the operation itself very well but succumbed late in convalescence. In the first instance, there was a large abscess of the right lower lobe which bled profusely. Within three weeks of the lobectomy the patient died from a spreading anaerobic infection of the chest wall. In the second, and more recent case, there was an abscess of the right lower lobe with almost daily hemoptysis from May until mid-August, 1935. A pneumothorax was only partially successful and failed to control the hemorrhages. A large characteristic, non-anaerobic, putrid lung abscess was found at operation. It involved three-quarters of the lobe and, in addition, had perforated the diaphragm into the right lobe of the liver. The resulting empyema was treated with zinc peroxide packing and irrigations. There was no further hemoptysis and the patient was doing well until the twenty-fourth day, when a sudden massive hemorrhage, both into the chest and by mouth, through the bronchial fistula, caused a fatal termination. The autopsy was exceedingly interesting. Not only had the abscess into the liver completely healed, but the perforation in the diaphragm had been repaired by a firm scar. The upper half of the pleural cavity was clean, the pleura smooth and glistening, and the lower half presented the picture of a healing empyema with granulation tissue and fibrin present. The lobectomy stump also was clean, but in one of the vessels there was a fresh clot, evidently the site of the fatal hemorrhage. The secondary hemorrhage could not have been prevented, it being a greater risk in infected cases than in those where an aseptic technique is possible.

Dr. Frank Meleney, New York, called attention to the fact that there are certain limitations and certain definite indications for the use of zinc peroxide. It is indicated in any infection from which anaerobic bacteria can be cultivated, including not only the gas gangrene group of bacilli, but also anaerobic streptococci and the intermediate group of micro-aerophilic streptococci, both hemolytic and non-hemolytic. In the case presented therefore, the use of zinc peroxide was definitely indicated and he is to be congratulated on the favorable outcome. Zinc peroxide has also had a favorable effect in a good many cases of ordinary hemolytic streptococcic infections. It is indicated particularly in the foul smelling types of infection. Apparently the foul odor is usually due to the anaerobic organisms, particularly anaerobic streptococci which are almost always present in lung abscesses, frequently in symbiosis with spirochetes and fusiform bacilli. Correspondingly, the foul smelling abscesses of the neck that occur following extractions of teeth, are usually controlled by the use of zinc peroxide. Likewise, at the other end of the alimentary tract, following operations for fistulas and rectal abscesses, the odor is almost immediately removed and the healing is very much cleaner and more permanent with the use of zinc peroxide than with other antiseptics. But, it is not indicated in the ordinary aerobic infections, and has no effect whatsoever on the staphylococcus or the Bacillus coli infections.

During the past year, there has been some difficulty in obtaining a standard preparation. Apparently there is only one

company making zinc peroxide and it has not been able to produce a powder that is exactly the same every time. The variations are apparently in its physical rather than its chemical properties, but these physical properties are of the utmost importance for its clinical effectiveness. For example, if it hardens and cakes it gives very much less favorable results than when it is soft and amorphous and makes a creamy suspension when mixed with distilled water. They are working on this standardization now and efforts are being made to correlate the clinical effectiveness with some simple laboratory test that would make it easy to ascertain if the material is being satisfactorily prepared. If this can be straightened, zinc peroxide ought to have a wide field of usefulness.

CASE II. HINGE FLAP FOR MULTIPLE BRONCHOPLEURAL FISTULAS

M. C., a woman of twenty-seven years, was admitted to the Fourth Medical Service, Bellevue Hospital, January 11, 1934, and discharged from the Fourth Surgical Service April 18, 1934. She had become suddenly and severely ill five weeks prior to admission, her chief complaint being a cough with excruciating pain in the right chest. The cough was nonproductive at first, and at no time did she expectorate bloody or rusty sputum. She had had, however, fever and night sweats, and the cough became productive "with a vengeance" three weeks after the onset.

On admission, the patient was desperately ill, emaciated and dehydrated and unable to take food. Her appearance, septic type of temperature, night sweats, cough with profuse expectoration, and a history that did not suggest a pneumonia, made differential diagnosis problematic. The various provisional diagnoses were ruptured cyst of the lung, lung abscess, and tuberculous cavitation with pyopneumothorax, and are mentioned to show that what proved to be a simple postpneumonic pyopneumothorax, easily diagnosed from hindsight, was a perplexing problem.

Pulmonary tuberculosis seemed inevitable and the laboratory technician was overworked seeking acid-fast organisms. None were found, although a pure growth of Type I pneumococcus was obtained.

The patient was transferred to surgery one week after admission. Due to the flattening of her chest and the proximity of the ribs, it was necessary to resect sections of the sixth, seventh and eighth ribs to evacuate, explore and pack the pleural cavity. The lung was found to be three-quarters collapsed and lying in the posterior gutter. A small portion of the apex was in contact with, and adherent to, the anterior chest wall. At this original operation, it was evident that bronchopleural fistulas were present. The productive cough subsided at once, but the lung resisted all ordinary therapeutic measures for re-expansion.

On March 27, 1934, when the drainage had become seropurulent and small in amount, an exploratory thoracotomy incision was made in the sixth interspace. Through this incision the partially collapsed lung, with its markedly thickened pleura, could be examined. Five separate bronchopleural fistulas were noted lying below the third, fourth and fifth ribs on the anterior surface of the lung, 2 inches from the sternal margin. The question then was how to close these fistulas. A pleuroplasty, in which a flap of pleura is folded over the fistula, would undoubtedly fail. The one feasible process was to cause adhesions between the visceral and parietal pleuras which, at the time of operation, were 1½ inches apart. A thoracoplasty would have accomplished this, but it seemed too major a procedure, so a hinge flap was devised.

Working through the original intercostal incision in the sixth interspace, the soft tissue was raised from the thoracic cage. This area of dissection extended from the right sternal edge to the anterior axillary line in the region of the third, fourth and fifth ribs. The ribs and costal cartilage were then resected subperiostally. The soft tissue flap thus produced, containing the intercostal bundles, rib periosteum and parietal pleura, was divided vertically from its sternal attachment and also from the second rib in the intercostal space. The parietal pleura of this flap and the corresponding visceral pleura were stroked with dry gauze, then painted with tincture of iodine.

The flap thus prepared was placed over the fistulous bearing portion of the lung and held in place by three mattress sutures. No further attempt was made to close the wound by suture. The wound closed practically per primam.

The pleural surfaces became adherent, and in one month's time the fistulas were completely closed, as was established by a negative smoke test. This test consists of a deep inhalation of a draft of cigarette smoke after which, with the mouth and nose closed, an expiratory effort is made. If a fistula exists, smoke will be seen coming from the chest wall wound.

The bronchopleural fistulas have permanently closed, as well as the drainage sinus in the chest wall. The patient has recovered her health and has remained well.

CASE III. POST-TONSILLECTOMY PERIPHERAL LUNG ABSCESS

H. R., a boy of seven years, was admitted to the Children's Surgical Service, Bellevue Hospital, May 12, 1935. Two weeks previously he had been admitted to the Manhattan Eye, Ear and Throat Hospital for tonsillectomy, which was performed under ether anesthesia. The following day there was evidence of a pathological process in the lower lobe of the right lung. One day prior to his transfer to Bellevue Hospital, twelve days after the onset of the chest pathology, 500 c.c. of pus, it was said, were aspirated from his right chest.

On admission to Bellevue Hospital, the boy was seriously ill. There was evidence of fluid in his right pleural cavity and many râles in the base of the left lung. The respirations were rapid and accompanied by an expiratory grunt. There was practically no expansion of the right chest. His pulse was rapid and he had considerable cyanosis.

It was evident that the boy was suffering from a right pyothorax with a beginning pneumonic process in the left lung. Roentgenograms showed a right pleural effusion extending from the apex to the diaphragm. The outline of the partially collapsed lung also could be observed.

On the day of admission, 70 c.c. of thick, putrid pus were aspirated from his right chest. On smear, this showed what was believed to be a streptococcus, with some other organism. The culture was reported ultimately as containing a pure growth of hemolizing streptococcus. Unfortunately, an anaerobic culture had not been made.

The question of therapy was a difficult one to decide:

1. Should the right chest be drained and if so, should it be done by the use of a catheter; that is, the so-called closed drainage?

2. Should it be opened widely, that is unroofed, since it was a fetid type of empyema?

3. Should we attempt to relieve the patient by repeated aspiration, considering that we were dealing with a process in the left lung?

4. Should a valve or "flapper tube" be introduced between the ribs? The "flapper tube" has all the advantages of open drainage and yet classifies as a closed type of drainage, since the pus has free exit but air cannot enter the pleural cavity. The finger cot attached to the outer end of the drainage tube makes an effective ball-valve with each inspiration.

We were dealing with a highly nervous, irritable, extremely sick child. He cried and struggled at the suggestion even of doing a paracentesis thorasis. This struggling and mental upset increased his cyanosis and pulse rate. We decided to make an intercostal stab wound and insert a "flapper tube." This was done under local anesthesia and all the pus in the pleural cavity was allowed to drain out at the time of operation. There was no shock. Roentgenograms taken immediately after the drainage showed the right lung to be 50 per cent collapsed, due entirely to the formation of the empyema and not to a collapse at the time of operation.

The clinical course for the next four days was very satisfactory. The child was definitely less toxic and seemed to be managing the contralateral pneumonia very well. However, there was a marked change on the fifth day. He became exceedingly sick, his respirations were 50 per minute, pulse 170, and he was deeply cyanosed despite being in an oxygen tent. On an emergency call to the hospital there was evidence of a large effusion in the left pleural cavity, which apparently was compressing the left lung. We were dealing with a 50 per cent collapsed right lung and a partially compressed left lung.

Paracentesis thorasis was performed on the left chest and 600 c.c. of straw colored fluid were removed. On culture this grew a Streptococcus hemolyticus. This was one of those rapidly forming effusions which, at times, occur in a streptococcus chest infection.

For the following ten days the patient was treated by repeated aspirations of the left pleural space, the amounts of fluid removed becoming progressively smaller and the con-

sistency greater. Fifteen days following the first pleural tap of the left chest, a "flapper tube" was inserted in the seventh interspace, postaxillary line. The left pleural space drained for the following three weeks, then closed permanently.

The right side, however, was not so amenable to treatment. A bronchopleural fistula eventually became demonstrable. This undoubtedly was part of the original process; that is a subpleural abscess which ruptured into the pleural cavity causing the fetid empyema and the partial lung collapse. Re-inflation of the right lung was a slow process. The temperature became more elevated and pocketing in the right chest was evident.

Again the proper procedure became a question. Should an exploratory thoracotomy be done and a search for multiple pockets made, or should we be content to make another intercostal incision and drain an evident anteriolateral pocket? Although an exploratory thoracotomy would have been the more satisfactory surgical procedure, the general condition of the patient would hardly have permitted such extensive surgery. Fortunately, a second intercostal drainage in the sixth interspace axillary line solved our problem.

The patient was discharged on July 25, 1935 to a convalescent home in the country. He has gained twenty-four pounds and is entirely well.

DISCUSSION. Dr. Howard Lilienthal, New York, expressed a preference for a two stage operation whenever possible. He said, also, that in all lung cases he prefers to start with a small dose of avertin. However, if there is profuse expectoration avertin must not be used because the patient may sleep so long afterward as to run the risk of infecting the sound lung. Since the ribs run spreading downward and forward, the best inspection of the inside of the thorax is obtained by making the incision in the intercostal space itself. Then, by dividing the rib posteriorly, a rib spreader may be used to give an excellent exposure.

Dr. Lilienthal felt that the under-water drain requires too much attention to be satisfactory. It has to be watched carefully in order to be sure it is under water and if the tube is not fairly long, an astonishing amount of water can be drawn into the tube on inspiration. He could not conceive of a case in which it would be absolutely necessary to employ it. The "flapper valve drain" can be used in almost any case, and is especially to be preferred when expansion of the lung is desired. A cough or an expiratory effort will flow out a certain amount of the fluid or gaseous thoracic contents and respiratory action will succeed more perfectly than any gradual action of the under-water drain to keep the lung expanded. All patients with hemorrhage should be bronchoscoped in an endeavor to find from where it arises. At operation as much as possible of the pedicle should be excised. So far, Dr. Lilienthal said, he had not noted hemorrhage by mouth. A material known as azochloramid, which comes in oily as well as aqueous preparations, is excellent when Dakin's solution cannot be used. It does not irritate the skin and deserves experimental trail. Although the temptation to do a thoracoplasty is strong in the presence of multiple fistulas, it is best not to do it so long as any lung remains that even remotely promises to function later. Do anything but a thoracoplasty whether the disease is tuberculosis or not. Every effort should be made to save the functioning lung.

SUMMARY

CASE I. Lobectomy for central abscess of lobe.

This patient was presented for the following special points of interest:

1. An abscess of the central portion of the lobe without peripheral pleural reaction, which is present in the great majority of these cases;
2. Practically no expectoration;
3. Abscess cavities filled with debris resembling the material expressed from the crypts of chronically infected tonsils;

4. Hemoptysis was the most important and urgent symptom;

5. One-stage lobectomy resulted in a complete cure;

6. A severe putrefactive, gas producing infection of the chest wall was controlled by the use of zinc peroxide.

CASE II. Hinge flap for multiple bronchopleural fistulas.

1. The short duration of the pneumonia followed by empyema;

2. The difficulty in making a differential diagnosis;

3. The surgical problem of closing multiple bronchopleural fistulas;

4. The use of a hinge flap which obviated the necessity of doing a radical thoracoplasty.

CASE III. Post-tonsillectomy peripheral lung abscess.

1. The production of a localized fetid empyema by rupture of a peripheral lung abscess;

2. That eternal vigilance is necessary in looking for and detecting contralateral lesions as well as pocketing of the original infection;

3. The rapidity with which a huge effusion is formed in the contralateral chest;

4. The presence of a bilateral empyema with recovery.

NEUROFIBROMATOSIS OF BLADDER AND PROSTATE*

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VON Recklinghausen[1] first described multiple neurofibromatosis in 1882 and showed that the tumors arise from the cutaneous nerve filaments. Since then much has been learned about this interesting disease. It is probable that all the forms of neurofibromatosis are essentially the same disease and that it is no longer a local disease of the skin but that the cutaneous lesions are simply one manifestation of a general constitutional disorder.

The picture of von Recklinghausen's disease, both the cutaneous form (fibroma molluscum) and the neurofibromata of the subcutaneous and deeper nerve trunks, is today familiar to all. Visceral neurofibromatosis is well known, but there have been only 6 cases of neurofibromatosis of the urinary bladder reported in the literature, and none with involvement of the prostate and seminal vesicles. This is probably due both to the uncommon occurrence of vesical involvement and to the paucity of autopsy material on patients dying of von Recklinghausen's or some concomitant disease. Other malformations and anomalies such as epispadias, cryptorchidism, bicornate uterus, polythelia, malformations of the kidneys, bones or muscles and dwarfism or infantilism are frequently associated with the disease picture.[2]

The following cases of neurofibromatosis of the urinary bladder have been reported in the literature:

Gerhardt's[3] (1878) patient was a thirty year old man who showed a marked generalized neurofibromatosis with many small tumors on the bladder neck.

Kyrieleis[4] (1885) reported the autopsy of an adult dying with neurofibromatosis who showed many pea sized nodules on the surface of the bladder.

Steden[5] (1923) reported a case of a thirty-one year old woman who complained of low backache, pain in the left side, obstipation, dysuria and dribbling. She had skin nodules on her back and right arm and a palpable cystic mass the size of a child's head in the pelvis. Laparotomy revealed the tumor to be the urinary bladder. The patient died two days later with symptoms of uremia. Autopsy revealed a tumor of the trigone encroaching on both ureteral orifices, dilatation and hypertrophy of the bladder wall, dilatation of both ureters and bilateral hydronephrosis. On microscopic section it was found that the skin lesions and the bladder tumors were identical.

Heusch[6] (1926) was the first to diagnose neurofibromatosis of the bladder during life. He made the diagnosis with a cystoscope in a fifty-three year old man on the basis of cutaneous manifestations. The diagnosis was confirmed at operation when a cystotomy was done and the previously observed bladder tumors removed from in front of the bladder neck.

Heidler's[7] (1928) patient was a sixty-eight year old married woman who had had skin tumors on her abdomen, head and external genitalia since the age of twenty-eight. She had never had bladder symptoms. On cystoscopy pea sized nodules covered with normal mucosa were observed. The picture resembled that of a high grade cystitis cystica except the nodules were larger and appeared solid and non-transparent. No biopsy was obtained as no interference was indicated but he believed the bladder tumors and skin tumors to be identical.

Kass[8] (1932) reported the only case seen in a child. His patient was a seven year old boy who had had an attack of hematuria and a history of enuresis. Bean-like nodules had been present on the neck, arms and trunk since birth. There was pigmentation of the skin and a suprapubic mass was felt bimanually. Pyelo-

* From the Department of Surgery of the University of Michigan. Read before the Section of Genito-Urinary Surgery, New York Academy of Medicine, March 18, 1936.

grams were negative, cystograms revealed asymmetry of the bladder and cystoscopy added nothing. The patient died from bronchopneumonia and sepsis complicating scarlet fever before further studies could be made. Postmortem examination revealed a large thick walled bladder with numerous tumors projecting from the surfaces. There was no obstruction to the flow of urine. Microscopic studies showed extensive neurofibromatosis of the bladder.

Fig. 1. Anterior view of patient on his first admission showing neurofibromatosis of the thigh, scrotum and prepuce.

Fig. 2. Posterior view showing typical fibroma molluscum.

The rarity of vesical involvement in neurofibromatosis and also the prostate, seminal vesicles and penis, simulating prostatism and ending in death from uremia, prompts the reporting of the following interesting case.

G. H., a white male, aged thirty-seven years, was first seen at the University Hospital in November, 1928, presenting multiple subcutaneous cirsoid neurofibromata over the entire body but more marked on the posterior aspect of the thighs, the scrotum and prepuce and causing displacement of the anus. The skin overlying these tumescences presented a diffuse brown macular eruption. There was an atrophic undescended testis in the left inguinal canal. At this time the tumor mass on the posterior aspect of the left thigh was excised and the patient had an uneventful convalescence.

The patient returned in January, 1931, complaining of rectal pain due to prolapse of the rectal mucosa by pressure of the tumor masses in the left buttocks. At this time, neurofibromata were excised from the left buttocks and a plastic operation was done to remove the prolapsed rectal mucosa. A circumcision was also performed to obviate the phimosis due to neurofibromatosis of the penis, the redundant foreskin being twice the length of the shaft.

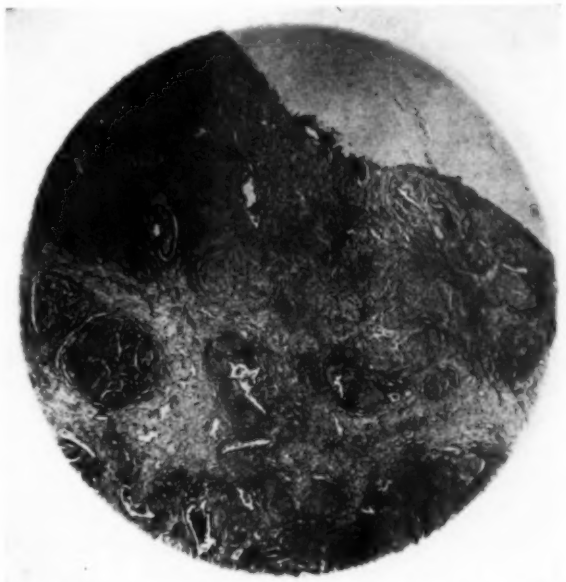

Fig. 3. Section of bladder wall showing the cirsiod neurofibromatous infiltration. (Low power. H. and E. stain.)

The patient did not return again until July 16, 1935, at the age of thirty-seven years. Six days prior to admission he had developed an acute urinary retention and had been catheterized intermittently by his local physician. There had been a history of progressive urgency and frequency with nocturia for several years. He was semistuporous on admission and was never entirely clear mentally during his hospital stay. There were multiple soft subcutaneous tumors over the entire body with a brownish pigmentation of the overlying skin. The peripheral vessels were moderately sclerotic. The blood pressure was 196/80. The heart was not enlarged and the lung fields were clear. The left testis was undescended and atrophic and the rectal sphincter was relaxed. The prostate was not enlarged upon rectal examination. There was bilateral costovertebral tenderness and the bladder was distended above the symphysis pubis.

Laboratory studies revealed the hemoglobin to be 95 per cent (Sahli), the white blood count 12,700 and the blood Kahn negative. The urine was alkaline, showed a 3 plus albumin, no sugar, and was loaded with red and white blood cells and bacilli; no phenolthalein excreted the first hour and 9 per cent the second hour. The blood non-protein nitrogen was 200 mgm. per cent and the whole blood chlorides 331 mgm. per cent on July 17, 1935.

Course in the Hospital. The bladder was gradually decompressed and the patient was kept on indwelling catheter drainage. He was sustained with oral and parenteral fluids. On July 29, two weeks after admission, the blood non-protein nitrogen had fallen to 112.5 mg. per cent. However, his general condition remained so poor that diagnostic cystoscopy was not deemed advisable as a method to determine the cause of the vesical outlet obstruction, but it was considered that a vesical submucous neurofibroma, similar to the cutaneous lesions, might be producing the obstructive phenomenon. Respirations became labored and ceased on August 12, 1935. At no time was the patient febrile and the blood non-protein nitrogen had risen to 154.5 mg. per cent a few days before death. The clinical diagnosis was renal insufficiency, bilateral chronic pyelonephritis, lower urinary tract obstruction (? of neurofibromatosis of the bladder), diffuse subcutaneous neurofibromatosis and left cryptorchidism.

The pathological diagnosis, reported by Dr. C. V. Weller, was as follows: "Neurofibromatosis (von Recklinghausen's Disease). Extensive cirsoid neurofibromatous infiltration in and about the prostate, prostatic urethra, bladder, seminal vesicles and penis. Neurofibromata of the vagus and intercostal nerves and jejunum. Cirsoid neurofibroma of the left

Fig. 4. Section of bladder wall under high power (H. and E. stain.)

Fig. 5. Section of bladder wall under high power better revealing the connective tissue elements. (Van Gieson's stain.)

buttock and thigh with scars of partial resection. Right nephrolithiasis. Ascending chronic purulent and ulcerative cystoureteropyelonephritis. Advanced pyonephrotic atrophy of both kidneys. 'Uremia.' Bilateral hematogenous fibrinopurulent lobular pneumonia. Bilateral acute fibrinous pleuritis. Right sided cardiac dilatation with an acute exacerbation of chronic passive congestion of all organs. Generalized parenchymatous degeneration. Left cryptorchidism. Old tubercles in bronchial and intercostal lymph nodes."

SUMMARY

1. A rare case of neurofibromatosis with involvement of the bladder, prostate, seminal vesicles and penis, and simulating prostatism in a thirty-seven year old male, and ending in death from uremia, is reported.

2. The importance of considering involvement of the genitourinary tract should be borne in mind in any case of von Recklinghausen's disease complaining of symptoms referable to the urinary tract.

3. Six cases of vesical involvement have been reported in the literature but we could find none in which the prostate and seminal vesicles were involved.

DISCUSSION

Dr. Russell S. Ferguson. This evidence has been cited previously by Masson. The neurofibromatoses, neurogenic sarcomas and melanomas are derived from the nevus cells, which is found chiefly in the peripheral cutaneous nerves and seldom in the visceral nerves, so that visceral neurofibromatosis is apt to be rare in all the hollow viscera.

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LARGE VESICAL CALCULUS

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VESICAL calculi are not uncommon but large ones are unusual though not rare. The largest bladder stone on record was reported by Randall and weighed four pounds.[1] The following instance is of interest because of its structure and emphasizes the ease with which a large vesical stone may be overlooked if one does not adhere to some routine plan in the physical examination of the urinary system. In this case a previous diagnosis of carcinoma of the prostate was later substantiated by consultation in another city. As the condition was considered advanced, palliative *x*-ray therapy to the pelvic area was given.

The patient, a slender adult male, aged fifty years, was first seen by us, on September 11, 1934, for increasing difficulty in starting the urinary stream with onset dating back six years. Later, besides delay in starting, he noticed that the stream would stop suddenly and became aware of a dull ache deep in the pelvis. About six months before consulting us the dull pain in the pelvis increased in severity and the frequency which previously was only of minor importance became marked. The patient also stated that on walking downstairs or stepping from a curb, the pain in the pelvis became sharp and so severe that it caused him to double up and grasp the lower abdomen with both arms. He was able to sleep on his back only, for any other position increased the pain in the pelvis.

When first seen the patient had a marked frequency, voiding every fifteen minutes, accompanied by a severe dysuria. Gross hematuria had been present intermittently for six months. The odor of the urine had been very strong and foul for the past year. On allowing a glass of urine to stand it was noted that approximately one-fourth of the contents consisted of pus. The urine was alkaline. Tests revealed albumin present in large quantity, but no sugar. Microscopically pus cells filled the field and red blood cells were few.

Physical Examination. There was no tenderness over the kidney areas nor were the kidneys palpable. Tenderness was elicited in the midline just above the symphysis and a hard mass could be felt through the abdominal wall in this region.

Rectal digital examination revealed a slightly enlarged prostate. The lateral sulci were easily outlined but were not deep. The median furrow of the prostate was absent at the base and this portion of the prostatic surface was somewhat but not markedly irregular, and felt stony hard to the examining finger. On bimanual examination, accomplished by pressing in the lower abdomen as indicated by the arrow in Figure 1, a large mass could be palpated between the left hand on the abdominal wall and the right index finger in the rectum. Examination of the external genitalia revealed nothing of importance.

A flat *x*-ray plate of the abdomen confirmed the presence of a large calculus in the region of the bladder, which almost filled the pelvis (Fig. 2). There was no evidence of renal calculus.

Examination of the blood on the day previous to operation, showed a hemoglobin of 90 per cent, red blood cells 4,600,000 per cu. mm.; white blood cells 7100 per cu. mm., with a differential of polymorphonuclears 86 per cent and small lymphocytes 14 per cent. Blood urea nitrogen was 14 mgms. per 100 c.c. of blood.

The calculus was removed by the suprapubic route on September 13. After the bladder was opened, my associate inserted a finger in the rectum and pressed up on the bladder base to facilitate removal of the stone. This caused thick greenish-yellow pus to exude around the calculus. The lower third of the stone was firmly adherent to the mucosa and was separated digitally with some difficulty. No structural abnormality of the bladder was present. The bladder was closed about a large Pezzar catheter. The lower two-thirds of the abdominal incision was left open and three

[1] YOUNG, H. H. Practise of Urology, 1926.

large cigarette drains were inserted and sutured in place.

The next day it was noted that the wound

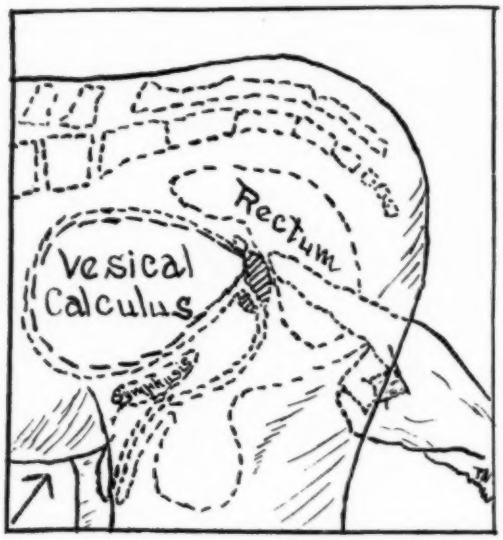

Fig. 1. Diagram of the calculus in the bladder illustrating how a mistaken diagnosis was made. Bimanual examination would have averted this error.

was infected, so all skin sutures were removed and hot moist boric acid packs were applied. Convalesence was otherwise uneventful for after the first twenty-four hours the patient's temperature did not rise above 100°F. He was

Fig. 3. A photograph of the calculus after removal from the bladder showing its size and shape.

discharged on the sixteenth postoperative day, dry suprapubically and voiding, but complained of slowness in starting the stream and a frequency of every two hours.

Rectal digital examination just prior to discharge from the hospital revealed a slightly enlarged prostate which was elastic in consistency and regular in outline, with no palpable evidence of carcinoma.

As further examination revealed that the patient had a residual urine of eight ounces he was treated by indwelling catheter until

Fig. 2. Flat *x*-ray plate of the pelvic region showing large vesical calculus.

the urine became clear. Since the patient was ambulatory he came to the office for daily irrigations. His catheter was changed every fourth day.

Cystoscopic examination on November 7, revealed a moderate enlargement of the median lobe and accompanying moderate enlargement of the right and left lateral lobes, but no

Fig. 4. A section of the stone lengthwise reveals that the calculus is made up of two stones.

significant prostatic enlargement in the deep urethra.

Intravenous phthalien test on the day prior to operation totaled 70 per cent, of which 60 per cent represented the first hour. Blood examination showed, hemoglobin 99 per cent, red blood cells 5,000,000 per cu. mm., white blood cells 6500 cu. mm., with a differential of polymorphonuclears 73 per cent and lymphocytes 26 per cent.

The obstructing portions of the prostate were removed by transurethral excision on December 7. The patient had an uneventful convalescence, being discharged on the seventh postoperative day.

Several check-up examinations have revealed a residual urine of less than ½ ounce. The patient has been working for a year and has had no further urinary difficulty.

The calculus weighed 527 grams, was 11.4 cm. long with a width of 8.6 cm. Its long circumference was 30.5 cm. and its greatest transverse circumference was 22.75 cm. (Fig. 3).

Section of the stone lengthwise (Fig. 4) revealed a most unexpected formation. Two distinct nuclei, each with its concentric lamina, make up the larger portion of the calculus. Examination of the structure shows that evidently the two stones were formed about the same time and enlarged at approximately the same rate. Finally when these stones reached a size which permitted practically no movement in the bladder, further deposition of salts on their unopposed surfaces firmly united them into one large calculus.

Chemical analysis revealed the salts present to be those commonly found in alkaline urine, namely calcium carbonate, calcium phosphate, and ammonio-magnesium phosphate (triple phosphates). A small amount of organic debris was also present.

The pathological examination of the excised portions of the prostate showed only evidence of benign hypertrophy with coexisting prostatitis. There was no evidence of malignancy or specific infection.

SUMMARY

An instance is presented in which a large vesical calculus was formed from two smaller stones by a further deposition of urinary salts, and in which a mistaken diagnosis of carcinoma of the prostate was made due to the lower portion of the stone pressing on the prostate gland. This error could have been averted by a routine physical examination of the urinary system. The importance of bimanual examination is especially stressed. It is particularly useful in examining for vesical calculi.

PERFORATION OF GALL BLADDER; EARLY GANGRENE OF COMMON DUCT

REPORT OF CASE

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IN the case presented the patient had a ruptured gall bladder and almost immediately afterward a gangrenous common duct. These two conditions, especially when in close sequence, are sufficiently extraordinary to be interesting.

The patient, Mrs. C. W. R., aged thirty-seven years, multipara, gave a practically negative history until two years previously, when she began to have attacks of lower right abdominal pain, of several hours duration. Two months before the present illness she had been hospitalized for fibrinous pleurisy following pneumonia. She had then had digestive symptoms of nausea, vomiting, anorexia, constipation, headache and dizziness. A cystoscopic examination done to investigate a moderately severe nocturia, had revealed a subacute cystitis and pyelograms had shown an enlarged left kidney with shadows in the region of the gall bladder, believed to be stones.

On readmission to the hospital, May 28, 1927, the patient's chief complaint was pain in the upper abdomen. One week before she had suffered a sudden, severe pain in the epigastrium which had radiated about the right costal margin to the right shoulder. This had recurred intermittently. There had been no nausea nor vomiting. Two days earlier she had noticed gray colored stools and had observed that her skin had a yellow tinge.

On physical examination, the upper right abdomen was exquisitely tender to palpation and slightly rigid. There was an excessive peristalsis but no masses could be felt. The patient's skin was dry and icteric. Her development and general appearance otherwise were normal. Her temperature was 100.6°, blood pressure 122/86, pulse 90 and respiration normal. Her chest was negative to auscultation and in the roentgenogram.

A study of the blood for urea nitrogen showed 13.31 mg. per 100 c.c. The coagulation time was 5 minutes, 10 seconds. The urine was orange colored and cloudy, and contained an average of 13 pus cells per h.p.f., and an occasional red blood cell. The stools were examined for bile but none was found.

A review of the roentgenograms made during the patient's previous period of hospitalization revealed several shadows in the region of the gall bladder and a single small shadow in the liver. No further roentgenograms were made at this time.

The preoperative diagnosis was subacute cholecystitis and cholelithiasis. Operation was advised and was performed May 30, 1927.

When the abdomen was opened, dense adhesions covering the gall bladder and between the liver and gall bladder were separated with difficulty. The gall bladder was thickened, atrophied, subacutely inflamed, and its fundus was gangrenous and had ruptured into the liver during a previous attack. The liver and omentum had formed a pocket, preventing contamination of the peritoneal cavity. Five stones were delivered from the liver posterior to the gall bladder. The ducts were then palpated and the hepatic ducts were carefully searched with a probe, but no stone was encountered. Because of the acuteness of the infection, surgery was limited as much as was consistently possible. The upper four-fifths of the gall bladder was removed; the stump and cystic duct were not disturbed, a procedure which later proved most advantageous. A tube was inserted into the cystic duct through the stump of the gall bladder and a cigaret drain into the gall-bladder fossa, and the incision was closed.

The patient's immediate postoperative condition was good. Her pulse rose to 130 and her temperature to 102.5° on the second day postoperatively, but on the third day the pulse subsided to 100 and remained practically stationary. The temperature continued to fluctuate between normal and 101°. Respira-

tion did not deviate appreciably from normal at any time.

Bile drained freely through the tube. No bile

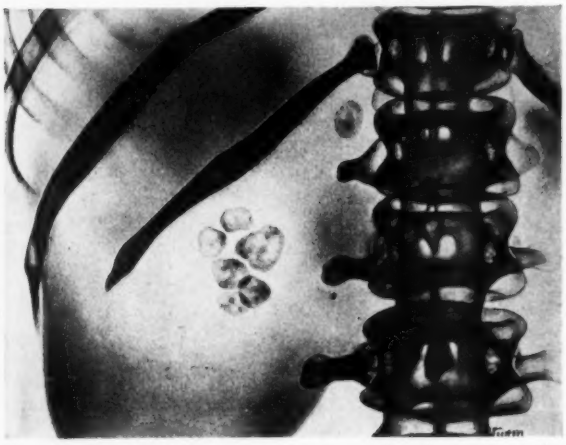

Fig. 1. Drawing from *x*-ray plate showing stones in region of the gall bladder and one stone high in liver.

appeared from the intestine after several days, however, and a chocolate milk taken by mouth passed undigested. The patient was extremely uncomfortable and complained almost constantly of a "cramping in the stomach," which often was so severe as to require an opiate for relief.

In two roentgenograms, made seven and eleven days after operation, there was no evidence of stone; the tube was observed covering the region of the solitary shadow seen in the first plate. Nevertheless, it was believed that a stone had descended from the hepatic duct and become lodged in the common duct. Since the patient seemed at a standstill in so far as her improvement was concerned, it was deemed best to explore for stone.

On June 13, 1927, therefore, the incision was reopened. Again, dense adhesions had to be separated before the operative field was visualized. When located, the common duct was found to be gangrenous and to contain a stone of irregular shape, approximately 3.4 cm. in diameter. The duct fell to pieces in the hand and was lifted from the abdomen. The proximal and distal portions of the severed duct were then ligated, a small rubber tube was placed into the stump of the gall bladder and cystic duct and anchored, and the free end of the cystic duct was brought down and anastomosed into the duodenum. One rubber tube was inserted to the outer side of the anastomosis, another to the right kidney fossa. The incision was closed with difficulty but was held with six retention sutures.

The patient's improvement was at once apparent. On the afternoon of the day of operation she was visibly brighter and stated

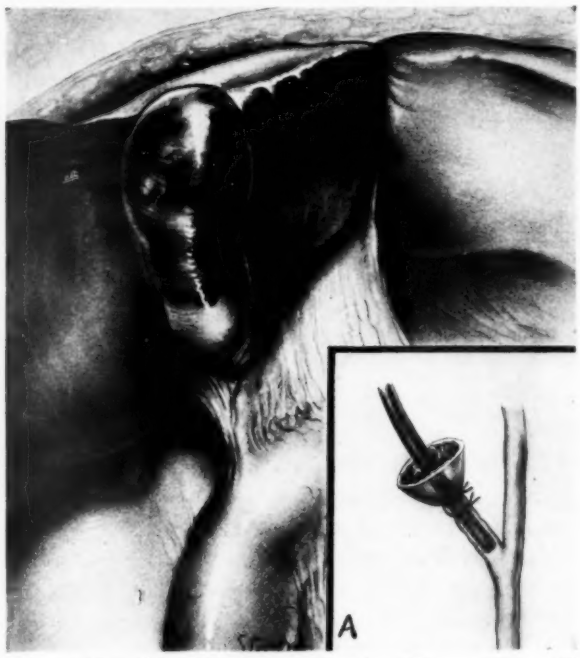

Fig. 2. Drawing from first operation. Gangrenous gall bladder containing pus and stones ruptured into liver. *a*. Stones and gangrenous portion of gall bladder removed. Tube inserted in stump of gall bladder and cystic duct.

that she felt better than at any time since being in the hospital. Her temperature continued to vacillate between normal and 101°, and her pulse remained at approximately 100 until the third week, when both began to return gradually to normal. The kidney function was good throughout.

Two days after operation the drainage from the wound developed a fecal odor, indicating a fistula. This increased for a few days, then began to diminish and disappeared entirely in four weeks. Bile appeared from the intestine on the third day and continued thereafter. On the sixth day one tube was removed from the wound, the other on the fourteenth day. The wound healed cleanly, the stools became normal in color and the patient's recovery was without further complication. She was dismissed from the hospital on July 29, 1927.

As she moved to a distant city some time later, we have not seen this patient in several years. She has written at intervals, however, stating in each letter that she has had no digestive trouble and no pain, and has been in excellent health at all times since her operations.

It has been estimated that 20 per cent of cases of acute cholecystitis proceed to perforation; also, that rupture of the gall bladder in itself carries a mortality of 10 per cent of the total operations on the gall bladder and ducts.[1] These high percentages are attributable to the fact that patients usually have symptoms of the disease for a number of years before seeking relief. The mortality would, no doubt, be much larger were it not for the fact that in many cases a protective wall is formed about the perforation, preventing escape of the evacuated contents into the peritoneal cavity and consequent peritonitis.

Studies have shown that the incidence of duct stones with cholelithiasis also is probably 20 per cent.[2] This complication contributes materially to the mortality of gall-bladder surgery; trauma to the tissues during the process of locating and removing the stones has a serious influence on the outcome. It sometimes happens, furthermore, that the stone cannot be discovered either by the probe or in the roentgenogram, as in this case. In 1923, Dr. W. J. Mayo showed that nearly one-third of the patients who died at the Mayo Clinic following operation for removal of common duct stones had one or more remaining.[3]

We can hope to reduce this high mortality of biliary disease only when the patient and physician fully realize the danger of postponing proper surgical treatment and seek early operation, preferably during a period of quiescence of symptoms.

Fig. 3. Drawing from *x*-ray plate showing stone from high up in liver dropped to region of common duct.

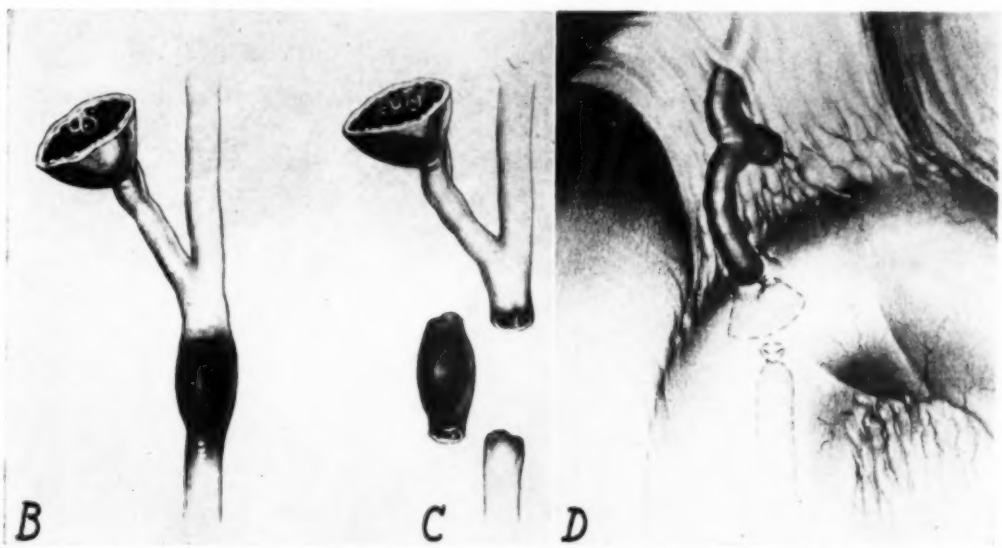

Fig. 4. *B.* Drawings at second operation showing stone lodged in common duct with gangrene of common duct. *C.* Gangrenous portion of common duct containing stone separated on manipulation. *D.* Operative procedure. Proximal and distal ends of common duct ligated; cystic duct with stump of gall bladder inserted into duodenum and sutured.

In view of the late stage of the diseases, the fact that one followed the other so early, the extent of the surgery, the postoperative development of a fistula and the danger of rupture of the anasto-

mosis, the result in this case is regarded as noteworthy after a period of almost nine years.

SUMMARY

1. A case is presented of gangrene and rupture of the gall bladder closely followed by gangrene of the common duct, the latter caused by the descent of a stone from the liver with resulting pressure.

2. If the patient had come to operation before gangrene and rupture of the gall bladder had occurred, a more thorough search could have been made for the hepatic stone, the necessity for a second operation obviated, and the normal biliary ducts preserved.

3. This case demonstrates the advisability of conservative surgery in complicated gall-bladder disease. By conserving as much of the gall bladder as was possible, the second operation was rendered comparatively simple.

4. The patient made an uneventful recovery and has remained entirely free of digestive disturbances during the nine years since the two operations.

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MALIGNANT TUMOR OF MECKEL'S DIVERTICULUM

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MT. VERNON, N. Y.

A CAREFUL review of the available literature reveals the extreme rarity of malignancy of Meckel's diverticulum, only 12 undisputed cases of which 6 were sarcoma, 4 carcinoid disease, 2 medullary carcinoma, and 3 myxomas of indefinite origin, and 3 of dubious origin, being found in the reports. A recent case of spindle celled sarcoma is of sufficient interest to be presented, as well as a brief summary of the previously recorded instances.

According to Ewing,[1] this diverticulum is found in about 2.7 per cent of the population. Balfour reports 15 cases in 10,600 autopsies, and Telling 39 cases in 13,068 necropsies. In 50,000 pathological specimens at Johns Hopkins Hospital, Copeland found but one case of tumor of this diverticulum, but its original site was indeterminate.

Kaufman[3] is the first to mention sarcoma when he states that the Basle collection contained a specimen of spindle celled sarcoma of Meckel's diverticulum. Fried[4] reports the postmortem finding of a massive tumor of Meckel's diverticulum, histologically diagnosed as fibromyosarcoma in a man aged fifty-five years who died of a wasting disease. Tschikanawerow's[5] case of sarcoma of Meckel's diverticulum of the spindle cell type was in a woman, aged sixty-two years, which at autopsy showed perforation and general peritonitis. Symmers[6] reports a case of myosarcoma of Meckel's diverticulum in a male, aged twenty-two years, discovered accidentally during an operation for hernia. Portman and Crile[7] report a case of partial intestinal obstruction in a woman, aged forty-one years, which was due to a spindle cell sarcoma of Meckel's diverticulum. Faust and Walters[8] stress the point that in intestinal hemorrhage of indeterminate origin, ulceration or tumor of Meckel's diverticulum should be considered, basing it on their finding of a fibrosarcoma of Meckel's diverticulum associated with massive intestinal hemorrhage.

Hicks and Kadinsky[9] in 1922, reported a perforated Meckel's diverticulum in a twelve year old boy, operated for supposed appendicitis. The pathological sections showed a strange mass of glandular tissue in the submucosa somewhat resembling pancreatic tissue although the arrangement was not pancreatic. There is considerable doubt in the minds of later observers that this may have been a case of pancreatic heterotopia, rather than of true carcinoid. Taylor and Stewart[10] in 1926, presented the first undisputed case of carcinoid tumor of Meckel's diverticulum. In a postmortem examination of a man, age fifty-four years, a pea shaped tumor was found at the tip of Meckel's diverticulum. Microscopic examination showed that the muscularis was broken and penetrated by columns and masses of tumor cells showing granules of argentaff with the silver stain. Price[11] reports an obstructed and inflamed Meckel's diverticulum about two feet from the ileocecal valve, in a woman, aged fifty-four years. Diagnosis was solid trabecular and acinar polygonal cell carcinoid. Hertzog and Carlson[12] found 2 cases of carcinoid of Meckel's diverticulum in 6138 necropsies at the Mayo Clinic. The tumors in both cases contained silver staining granules.

Wisely[13] reports the first case of medullary carcinoma occurring in this location. The tumor was discovered while exploring the appendiceal region through a herniorrhaphy incision. Sections showed medullary carcinoma with many mitoses. Brown[14] reports a degenerating medullary car-

cinoma in a rancher, aged sixty-six years. The preoperative diagnosis was appendiceal abscess. The tumor was twenty inches from the ileocecal valve and histologically was composed of atypical epithelial cells in single cords with mitotic figures.

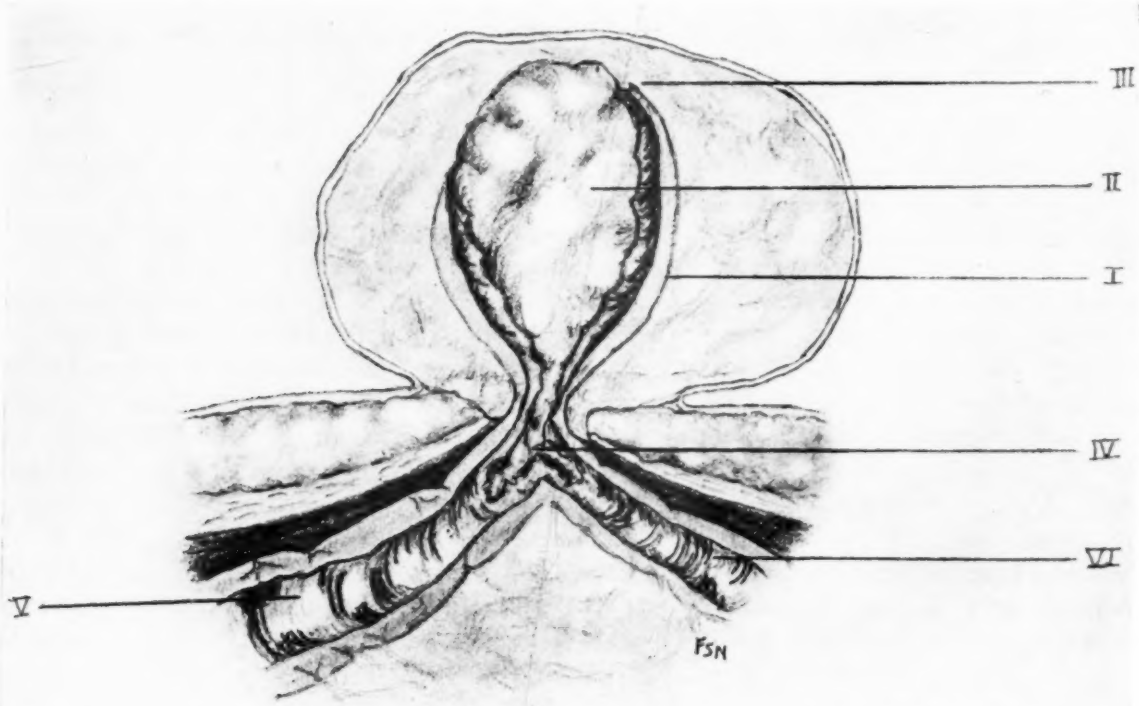

Fig. 1. Schematic drawing showing I. strangulated Meckel's diverticulum forming major component of umbilical hernia; II. spindle cell sarcoma arising from apex of diverticulum; III. point of perforation; IV. ball-valve obstruction of afferent ileal loop by protrusion of pedunculated part of tumor through neck of diverticulum.

Haessner[15] in 1913, reports a "rapidly disintegrating, apparently malignant tumor in the region of the ileum, apparently attached to Meckel's diverticulum." While it was impossible to state definitely that the lesion had its origin in the diverticulum, the author felt that such was the case. Black[16] in 1913, reported a large myxomatous tumor weighing 4600 grams, arising from the tip of a sigmoidal diverticulum believed to be Meckel's. Symmers states that, although rare, it has been found and reported in the sigmoid.

Meckel's diverticulum is due to the persistence of the vitelline duct with or without its accompanying omphalomesenteric blood vessels and usually arises within 30 inches of the ileocecal valve, generally from the anti-mesenteric border varing from 1 to 5 inches in length. Frequently the tip is connected to the umbilicus by slender cords which are the remnants of the vitelline blood vessels and occasionally may be the causative factor in intestinal strangulation. The diverticulum may originate from any point in the gastrointestinal tract, from the stomach to the rectum.

The intrinsic pathology is variable and interesting. Inflammatory lesions closely mimicking acute appendicitis are common and should be considered when the appendix at operation does not fit the preoperative clinical picture. Fecolith obstruction, tuberculous ulceration, typhoid ulcer perforation, gastric heterotopia with complicating ulceration, massive hemorrhage and perforation, pancreatic heterotopia, endometriosis, intussusception and voluvulus obstruction have all been reported associated with this diverticulum.

CASE REPORT

A. A., white, female, aged sixty years, was admitted to the Mt. Vernon Hospital on October 30, 1934, because of violent abdominal cramps and vomiting of four days duration.

Associated with these symptoms were gradual increase in size and extreme tenderness in an umbilical hernia which she had noticed for twelve years. The vomiting was persistent and of the intestinal type but not definitely fecal. There had never been any similar episodes.

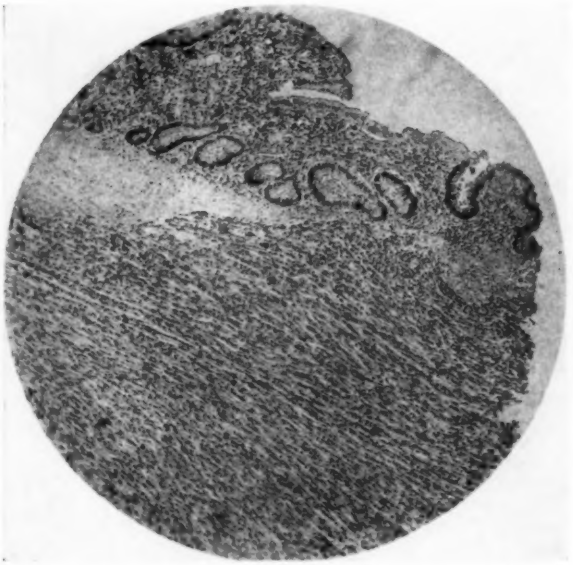

Fig. 2. Section through tumor showing overlying mucosa of diverticulum and invasion of submucosa.

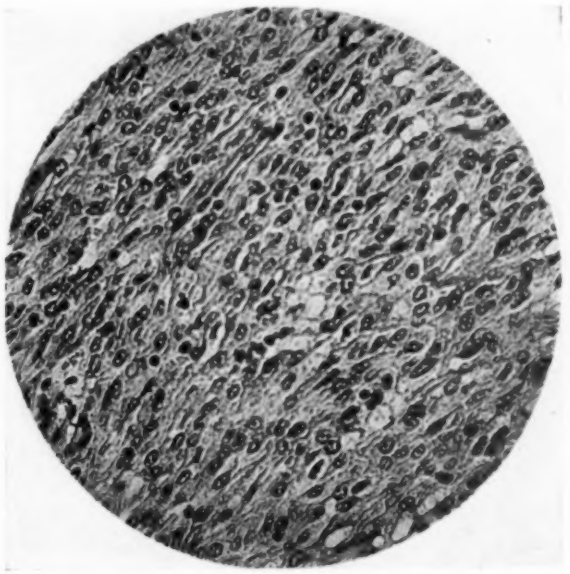

Fig. 3. High power section of typical area of tumor showing spindle shaped anaplastic cells with many mitotic figures.

She suffered a left hemiparesis one year prior to admission.

Physical examination revealed an acutely ill, elderly female, slightly cyanotic and semi-stuporous with poor orientation; temperature 99.8°, pulse rate 100 and respiration 20; blood pressure 190/100. The heart and lungs were essentially negative.

A hard, irregular, very tender, umbilical protrusion, about 6.5 cm. in diameter was irreducible.

The blood findings showed hemoglobin 49 per cent; erythrocytes 4,400,000 and 14,200 leucocytes with 64 per cent polymorphonuclear cells. The red cells showed achromia, basophilic stippling and polychromatophilia.

The urine showed a heavy trace of albumin with 20 hyaline and granular casts per field.

Operative Findings. A large multilocular umbilical hernia was found with firm adhesions to the gut and omentum in the largest pocket of which was a strangulated Meckel's diverticulum 2 inches long, with a gangrenous and perforated apex. It was filled by a lobulated and pedunculated tumor mass which extended through the neck of the diverticulum and almost completely plugged the lumen of the ileum from which the diverticulum originated, being attached only to the apex of the diverticulum.

We were confronted with the unusual pathology of an umbilical hernia, strangulated at its neck causing a perforative gangrene of its major component, a diverticulum of Meckel containing a malignant tumor which in turn was causing an internal ball-valve obstruction of the ileum.

The ileum with its diverticulum was quickly resected and an end-to-end anastomosis completed. The hernia was repaired according to the Mayo technique.

Course. For the first twenty-four hours postoperatively the patient appeared to be doing well. She then developed signs of toxemia with marked delirium and died abruptly forty hours postoperatively. Autopsy could not be obtained.

Eggston's pathological report was "spindle cell sarcoma of Meckel's diverticulum."

SUMMARY

A case of sarcoma in Meckel's diverticulum with a brief summary of the literature have been presented.

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[*For Remainder of References see p.* 106.]

LEFT INTRAPERITONEAL HERNIA*

CASE REPORT

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ANOMALIES in the relationship of the peritoneum to the intestine are of inherent interest to the embryologist, and of practical importance to every abdominal surgeon. The following, like a number of previous ones, was discovered in the dissecting room.

The body was that of a well developed and nourished Negro male, about twenty-eight years of age, with no external evidence of bruises or wounds. The cause of death could not be determined. The dissection of the extremities and thorax revealed no gross pathology or anomalous organs.

On opening the anterior abdominal wall by a midline incision, the greater omentum was seen to be of normal appearance and distribution. The large intestine appeared normal and pursued its normal inverted U-shaped course; the ascending and descending colons had no mesenteries while the transverse and sigmoid colons possessed their normal mesenteries. The appendix was in a retrocecal fossa pointing directly upwards, normal in length and appearance.

When the greater omentum was thrown upwards and backwards the small intestines were seen to be enclosed in a peritoneal sac lying on and to the left of the lumbar vertebra. This sac measured 20 cm. transversely and 25 cm. vertically, (Fig. 1), the terminal part of the third portion of the duodenum entering the sac at its upper right corner. The best description of this condition is given by Moynihan in 1906. He describes it as, " . . . an agglutination of the mouth of the hernial sac with the anterior wall of the duodenum and of the duodenojejunal flexure. The result is that the highest portion of intestine contained within the sac, the duodenojejunal flexure, seems to come, not through the mouth of the hernia, but through the actual wall of the sac." The terminal part of the ileum left the sac through an opening in about the center point of the right border of the sac just large enough to allow its exit and joined the cecum normally, the ileum lying outside of this sac measuring 9 cm. This sac had a definite posterior wall but its neck was attached to the posterior parietal peritoneum overlying the lumbar vertebra. The hand could not be slipped between the posterior border of neck of sac and the parietal peritoneum overlying the lumbar vertebra on the left side, but the fingers could be slipped between the anterior border of neck of the sac and the parietal peritoneum on the right side of the lumbar vertebra inwards until the fingers met the mesentery of the small intestines inside the sac, (Fig. 3). There were very few adhesions between this sac and the parietal peritoneum.

The sac containing the small intestines was opened by incision and explored, (Fig. 1). It contained all the small intestines except the terminal 9 cm. of the ileum. There were no adhesions inside the sac except the first 20 cm. of the jejunum were agglutinated to the upper wall of sac; nor were there any areas of constriction or dilatation suggesting intestinal obstruction. No openings were found into the sac except the two described. The primitive layers of the wall of the sac could not be demonstrated. The mesentery of the small gut was attached to the posterior abdominal wall in midplane from levels of the second to the fifth lumbar vertebras and contained the usual branches of the superior mesenteric

* The authors wish to endorse the suggested change in nomenclature on duodenal hernia proposed by Callander, et al 1935.

vessels. The small intestines could not be pulled out of the sac because of a bridge (x, Fig. 3) between the openings, which is probably due to "physiological adhesions" of Neubauer, to which Moynihan referred. The superior mesenteric artery had normal origin and distribution and it crossed superiorly and anteriorly to the third part of the duodenum as it does normally, (Fig. 2). The anterior wall of the neck of the sac contained the inferior mesenteric vein accompanied by an ascending branch of the inferior mesenteric artery.

The right lobe of the liver had a stellate fissure on its superior and anterior surfaces opposite the right end of the gall-bladder fossa extending 7 mm. into the liver substance.

The right kidney was of normal size and located on the lateral wall of the pelvis overlying the right hypogastric vessels and its ureter originated from its anterior surface and entered the bladder normally. The right suprarenal gland was in its normal position behind the liver. The other organs were normal in position and gross appearance.

Fig. 1. Photograph of dissection showing small intestines enclosed in a peritoneal sac which has been incised. *A*, peritoneal sac; *B*, jejunum; *C*, cecum; *D*, transverse colon.

Fig. 2. Photograph of dissection showing the superior mesenteric vessels passing anterior to the third part of duodenum in normal relationship. A tube is inserted through the third part of the duodenum. The greater omentum is overlying the peritoneal sac containing the small intestines. *A*, superior mesenteric vein; *B*, superior mesenteric artery; *C*, cecum; *D*, greater omentum.

DISCUSSION

Since the classic description of intestinal rotation by Mall in 1898, a number of writers have reviewed the literature on intestinal anomalies and have reported new cases. Comprehensive discussions on the causes concerned in various intestinal anomalies, reviews of the literature and tabulation of cases observed have been published by Frazer and Robbins, 1915; Andrews, 1923; Dott, 1923; Short, 1924–25; Haymond and Dragstedt, 1931; Gardner and Hart, 1934; and Callander et al, 1935. To these mentioned articles and to the monograph on retroperitoneal hernia by Moynihan in 1906, the present writers refer the reader for details.

A point of interest is the unexplained high incidence of intestinal anomalies

in the male. Our case, also a male, differed from the one recently described by Callander et al, in that the sac had a definite

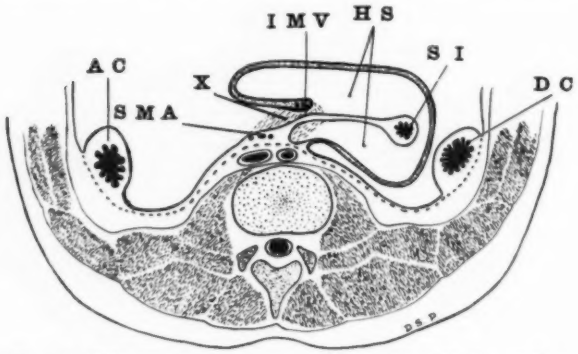

FIG. 3. Diagram of a cross section through the region of the hernial sac. *AC*, ascending colon; *DC*, descending colon; *HS*, hernial sac; *IMV*, inferior mesenteric vein; *SI*, small intestines; *SMA*, superior mesenteric artery; *X*, adhesions.

posterior peritoneal wall distinct from the posterior parietal peritoneum, similar to Case 1 recently described by Haymond and Dragstedt in 1931. Furthermore secondary fusions, "physiological adhesions," had nearly obliterated the opening into the sac. On the other hand the relationship of the superior mesenteric artery to the duodenum was normal. This artery did not lie posteriorly as in the case reported by Haymond and Dragstedt. The right anterior edge of the neck of the sac contained the inferior mesenteric vein and a small artery. Possibly herniation occurred into the descending mesocolon after it was no longer mobile, the sac enlarging as the small intestine developed.

SUMMARY

A case of a large left intraperitoneal herniation of practically all of the jejunum and ileum is reported in detail.

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* *Continued from p. 103.*

HUGE VENTRAL HERNIA COMPLICATED BY INCARCERATION OF GANGRENOUS ILEUM

CASE REPORT

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INDIVIDUAL case reports are today seldomly justified in our overcrowded medical literature, unless they present very rare conditions or are of extreme interest as curiosities. The case briefly presented, falls into the latter category. This report demonstrates how completely certain individuals will purposely neglect anatomical defects which at their onset are quite amenable to complete eradication by surgical procedures.

A Mexican housewife, aged sixty years, entered the Los Angeles County General Hospital at 5:10 P.M., February 22, 1936, complaining of a spontaneous fecal fistula through the lower anterior abdominal wall of seven days' duration and of severe, generalized, crampy abdominal pains for the past two days.

The salient points of the patient's history were briefly as follows: Fifteen years ago, she noted the onset of a small ventral hernia in the midline of the abdomen equidistant between the umbilicus and the symphysis pubis following some excessively heavy lifting about her home. However, no medical advice was sought at that time. Ten years ago, the steadily enlarging ventral hernia became infected and was complicated by the appearance of a fecal fistula which, for eighteen months, drained small bowel content, then closed spontaneously of its own accord. During the next eight and one-half years, the patient enjoyed fair health despite the fact that the ventral hernia was constantly increasing in size and that she was experiencing an ever increasing number of short acute attacks of colicky cramp-like abdominal pains in the region of the hernia that were associated with nausea and vomiting. Seven days before entry into the hospital, the apex of the now markedly pendulous ventral hernia, which had been chronically inflamed during the past year, broke down and a fecal fistula reappeared discharging large amounts of foul smelling small bowel content. Two days prior to hospitalization she became so sick from the severe abdominal pain and vomiting that she was forced to go to bed but with no improvement from home remedies, she was brought to the emergency ward of the hospital for treatment.

The physical examination revealed a very obese Mexican female of about sixty years of age, complaining of pain in the lower abdomen, who was obviously quite ill. Her face and extremities were cyanotic and covered by a cold clammy sweat. She presented the typical clinical picture of shock. Mouth temperature was 98.6°F.; respirations were recorded as 18 per minute; while the pulse was weak, thready, of irregular poor character with a rate of 80. The rest of the physical examination was essentially negative except for the abdomen. Here a huge ventral hernia was encountered arising from the midline below the umbilicus and extending caudad well towards the knees. The walls of the hernia were edematous, subacutely inflamed, of a dark purplish hue and contained numerous large dilated veins. The outside dimensions of the hernia were 38 cm. long by 27 cm. wide by 25 cm. in an anteroposterior direction. At the apex of the herniation was an ulcerated region measuring 19 × 10 cm., in the middle of which was a common cloaca 5 cm. in diameter into which emptied two fistulas discharging foul smelling ileal content. Figure 1 graphically portrays the appearance of the abdomen upon hospital entry. The patient was obviously such a poor surgical risk at that time that emergency measures consisting of bed rest, opiates to control the abdominal pain, continuous duodenal-nasal tube drainage, frequent small hot saline enemas, dry electric heat to the abdomen, nothing by mouth, and the administration of fluids by both the intravenous and the hypodermoclysis routes in amounts of 3000 c.c.

daily were urgently indicated. The blood studies and the blood Wassermann test were negative. The patient steadily failed and at no time did her condition sufficiently improve to permit surgical intervention. The temperature remained subnormal and she was mentally clear until the last day. Death occurred on the seventh day following her hospital entry.

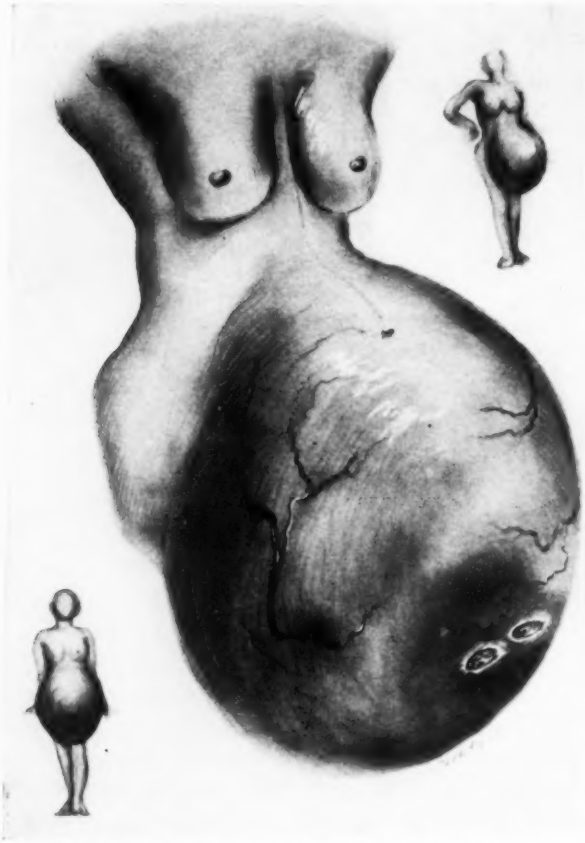

Fig. 1. Diagramatic drawing of findings and gross appearance upon patient's entry to hospital. Note huge extent of ventral hernia with two fistulous openings at the apex surrounded by an area of subacute inflammation.

Postmortem examination revealed the abdominal findings depicted in Figure 2. Upon opening the peritoneal cavity, a large amount of foul serosanguinous fluid was encountered. The ileum, hepatic flexure of the colon and most of the transverse colon were absent from the abdominal cavity. The duodenum and jejunum were greatly dilated and presented the characteristic appearance of a long standing chronic bowel obstruction which had recently become complete. The jejunum was beginning to become gangrenous in areas and its vascular supply showed extensive thromboses. A ring-like opening was present in the midline of the anterior abdominal wall 8 cm. below the umbilicus, whose diameter measured 9 cm. Through this stoma could be observed

Fig. 2. Diagrammatic drawing of findings at postmortem examination. The entire ileum and portions of the ascending and transverse colon are absent from the abdominal cavity. The duodenum and jejunum are markedly dilated with beginning gangrene. The entire ileum lies within the hernial sac and is gangrenous. The cecum and the proximal portion of the ascending colon remain within the abdominal cavity and are viable although greatly dilated, due to obstructed distal colon within the sac. The distal portion of the ascending colon and two-thirds of the transverse colon are within the hernia. The left transverse colon and the remaining distal portions of the large intestine are viable but collapsed. The greater omentum was partially within the herniation also, but has been cut away in this drawing for purposes of clarity.

the disappearance of the entire ileum with its emergence again near the ileocecal juncture. The cecum and proximal ascending colon were considerably dilated. The ascending colon 7 cm. above the cecum again disappeared into the internal ring of the hernia to emerge again

in the region of the left transverse colon 6.5 cm. from the sigmoid flexure of the colon. A large amount of the greater omentum had also been drawn into the hernial sac. Upon dividing the hernial internal ring, it was found that the entire ileum was gangrenous with two spontaneous external fistulas situated in the lower ileum, 15 cm. apart. The mesentery of the ileum was gangrenous and its numerous vessels were thrombotic. Strange to say, the colon, although firmly incarcerated in the hernial sac, was in fairly good condition and was not gangrenous. Considerable areas of the greater omentum were thrombotic and acutely inflamed. The splenic flexure and the remaining distal portion of the large intestine were collapsed.

The chief causes of death were incarcerated ventral hernia, mechanical intestinal obstruction, gangrene of the ileum, peritonitis and chronic salpingitis. The contributary cause of death was marked obesity.

SUMMARY

A case report is presented in which a huge, non-operative ventral hernia, of fifteen years' duration, became incarcerated causing gangrene of the entire ileum and contained a large portion of the greater omentum, ascending and transverse portions of the colon. Two illustrations demonstrate the interesting anatomical features of this case.

CONTUSION OF HEART WITH AORTIC REGURGITATION; COMPLETE RECOVERY

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THE heart formerly was considered relatively immune to non-penetrating trauma. Beck,[1] however, questioned the accuracy of this concept and has demonstrated that certain definite phenomena follow experimental contusion of the normal healthy heart.

Investigation of trauma to the heart is difficult on account of the confusion with which authors report their cases, little effort being made to distinguish the previously healthy heart from one well advanced in disease, or to separate the heart damage due to effort on the part of the victim from that due to trauma in the usual sense of the word. Bright and Beck,[2] after a careful analysis of the literature accepted 176 cases of actual contusion of the heart, only 12 surviving the injury and only 7 recovering without some evidence of heart damage. Since their report Elkin[3] has added 2 cases resulting in complete recovery.

The following case is recorded because it occurred in a previously healthy youth, presented a striking clinical course, and was followed by prompt and complete recovery.

W. H., an unmarried white youth, aged eighteen years, was thrown from an automobile when it was wrecked on September 13, 1933. His family history was not unusual. He had always enjoyed excellent health and was actively athletic. Recent examinations by his family physician and school examiner had failed to disclose any abnormality.

The patient was unconscious for a few minutes following the accident but upon regaining consciousness he complained of severe precordial pain. A physician summoned to the scene administered morphine sulphate, ½ grain, by hypodermic, and when seen at Saint Joseph's Infirmary two hours later the patient was still under the influence of the drug. Careful examination failed to reveal any serious injury although there were numerous minor contusions and brush burns about the face and upper extremities, and the coat had been literally rasped from the body. The blood pressure was 110/65. There was an unexplainable tachycardia, rate 130–140 per minute, the heart sounds were clear and there were no murmurs or thrills, but the two sounds resembled each other more closely than usual. Because of the tachycardia, roentgenograms of the chest were made, which showed no evidence of injury to the skeleton, heart or lungs.

Urine voided four and one-half hours after injury showed no pus or blood, but almost boiled solid with albumin and contained innumerable hyaline and epithelial casts. On account of the urine picture the chemistry of the blood was studied, but it showed normal creatinine and non-protein nitrogen content. The unexplained tachycardia continued and digitalization was begun, using the method of Eggleston.

Twenty-four hours after injury the urine showed only a faint trace of albumin and an occasional hyaline cast. No explanation could be offered for this remarkable change.

For the next few hours there was little change in the patient's condition except that gaseous distention of the stomach necessitated the use of the Levine tube. The tachycardia continued and a noticeable fluctuation of the blood pressure began, readings varying rapidly from 100 to 120 mm. Hg. systolic and from 60 to 70 mm. diastolic.

At thirty hours restlessness increased, the pulse assumed a bounding character and the aortic closure sound became very harsh. The blood pressure was 130 mm. systolic and 50 mm. diastolic.

The restlessness increased in spite of morphine, it being difficult to keep the patient in bed. He complained incessantly of being hot and short of breath. At thirty-three hours, signs of aortic insufficiency were detected. The blood pressure was 140 mm. systolic and

30 mm. diastolic. A loud systolic and diastolic murmur was heard over the base of the heart and over the great vessels well into the femoral artery. A Corrigan pulse and capillary pulsation were noted. At thirty-four hours the blood pressure was 160 mm. systolic and the sounds did not disappear at 0. Cyanosis rapidly developed and deepened and the patient appeared to be in extremis. He was placed under an oxygen tent and at a consultation some forty minutes later, a loud pericardial friction rub had developed establishing the diagnosis of serious heart injury, and since the patient had received 23 grains of digitalis the addition of sparteine sulphate was suggested. An ice cap was to be kept over the precordium constantly.

Very little change in signs or symptoms occurred during the next twenty-four hour period but the restlessness decreased and oxygen therapy controlled the cyanosis. From that time, however, there was slow but gradual improvement until the fifth day after the injury, capillary pulsation could no longer be detected and the blood pressure was 144 mm. Hg. systolic, diastolic change at 60 mm., all sounds disappearing at 0. The aortic sounds were shorter and more distinct. The oxygen therapy was gradually decreased and discontinued on the seventh day. At that time the pericardial friction rub disappeared, the aortic closure sounds became clearer, and the blood pressure was 140 mm. systolic, diastolic change at 65 mm., disappearance at 35 mm.

On the eighth day the heart sounds were clear and distinct. There was very slight prolongation of the mitral first sound as well as both aortic sounds. The femoral sign was barely perceptible. The blood pressure was 135 mm. systolic and 70 mm. diastolic, with complete disappearance of sounds at 50 mm.

Urinalyses subsequent to the third day after injury were constantly normal until on the tenth day the urine became mahogany colored due the presence of hemoglobin. The benzidene test was graded four. There were no red blood cells, leucocytes, or casts. Hemoglobinuria continued unabated for three days, after which it steadily diminished until it disappeared at the end of a week. At no time was there jaundice, ecchymoses, hemorrhage or other symptom of blood destruction except moderate anemia.

On the eleventh day after injury the patient had recovered sufficiently to be transferred to a hospital in his home city in an adjoining

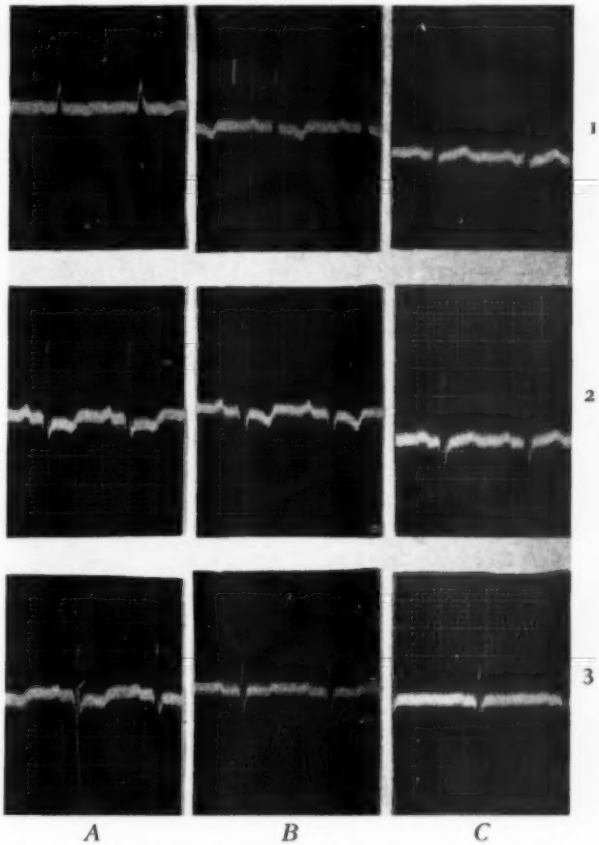

Fig. 1. Electrocardiograms: *A*. Sept. 15, 1933, during period of complete aortic insufficiency; *B*. Sept. 19, 1933, during period of early recovery; *C*, July 7, 1934, ten months after injury.

state. His physician states that the apex rate continued rapid for several days, but there was no abnormality of the heart sounds. *X*-ray pictures taken then revealed a small amount of fluid in the left pleural cavity but none in the pericardium.

The patient was transferred to his home at the end of the third week and remained in bed for four more weeks, when physical examination and fluoroscopy disclosed no evidence of previous heart disturbance.

Nine months after the injury the patient was feeling well, played tennis and indulged in swimming. He had no symptoms of any heart condition. Physical examination showed the heart to be of normal size, the apex beat was in the fifth intercostal space well within the midclavicular line and all sounds were normal. The blood pressure was 100 mm. systolic and

65 mm. diastolic. The diastolic change was not as prolonged as is usual in normal hearts. Fluoroscopy showed the heart to be normal in size and contours, but there was some obliteration of the left phrenocostal sinus.

Electrocardiographic studies fifty-eight hours after injury during the period of complete aortic insufficiency showed low voltage, biphasic T waves and in leads 2 and 3, slight depression of the S-T segments below the base line. Study four days later, as recovery began, showed more decided T wave changes, but the depression of the S-T segment had disappeared. Electrocardiograms taken at the Vanderbilt University Heart Station ten months after injury were normal in every respect.

COMMENT

Beck's experiments showed that a latent period of definite symptoms usually follows contusion of the heart. The most constant feature is tachycardia with what he describes as a "*tick-tick*" rhythm. At the end of this period softening of the contusion occurs, with pericardial effusion. If the contused area involves enough of the myocardium, rupture of the heart may result in death from pericardial tamponade.

The case described herein must have been one of contusion of the left ventricle near the conus arteriosus, with subsequent edema which interfered with closure of the aortic cusps. It is hardly conceivable that tearing of the cusps of the valve would not result in immediate insufficiency, nor would prompt and complete recovery be expected. The peculiar tachycardia was in keeping with Beck's experimental observations in dogs, and the delay of onset of urgent symptoms only slightly exceeded his latent period.

Of further interest is the fact that although there were many minor contusions and abrasions about the chest and shoulders, the thoracic skeleton apparently escaped serious injury.

The initial albuminuria is difficult to explain in the light of its rapid disappearance. Hemoglobinuria was probably due to absorption; but its severity indicated blood destruction on a rather large scale from the pleural and pericardial hemorrhage.

SUMMARY

A case of contusion of the normal heart is reported. There was a latent period of thirty hours, characterized by tachycardia, precordial and epigastric pain, distention of the stomach and marked albuminuria. Aortic insufficiency then rapidly developed, followed by pericardial effusion. After remaining stationary for twenty-four hours, the condition began to improve slowly. The end result was complete recovery without physical or electrocardiagraphic evidence of heart defect.

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TRANSURETHRAL RESECTION OF BLADDER TUMORS

REPORT OF THREE CASES*

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ELECTROCOAGULATION, as brought out by Beer, has long had its place in the treatment of bladder tumors.

Before the advent of the electrotome with its more refined electrical currents, fulguration was limited as the operator was restricted in the amount of tissue which could be destroyed and that the more malignant tumors would not respond to it. The electrotome offered the possibility of destruction of even the largest sized papillomata, as well as some of the more malignant growths.

It is not suggested that all malignant tumors of the bladder be treated in this manner. There are some, particularly the sessile, infiltrating growths, that are not adaptable to this form of treatment, and must be treated with radium, *x*-ray or resection. In the malignant growths which are treated with it, the electrotome seems to be an ideal instrument, for it seals the channels of dissemination with each stroke of the instrument.

The technique is obvious to anyone who has used the electrotome. It has been found advantageous to cook the tumor thoroughly with a coagulating current before any attempts at resection with a cutting current are tried. This prevents uncontrollable bleeding from points which cannot be visualized, which might necessitate suprapubic cystotomy.

This treatment offers an economic advantage to the patient who needs to be hospitalized for only twenty-four hours with each treatment.

All of these cases have been done under caudal anesthesia because it is the simplest form of anesthesia. There are dangers connected with this treatment, i.e., perforation of bladder wall, occlusion of a ureteral orifice when it is involved in the growth, and hemorrhage, which has been discussed. Care and conservatism in the amount of tissue removed at one sitting will obviate the first two dangers.

This method of treatment has been found successful in dealing with (1) large benign tumors, (2) as a minimum procedure in bad surgical risks, and (3) even in highly malignant tumors.

One case of each group is presented.

CASE I. A man, aged forty-nine years, was admitted to the Hospital for The Ruptured and Crippled on May 7, 1935, for painless hematuria. Cystoscopic examination revealed a large papillomatous tumor, more than half filling the bladder when the latter was distended with twelve ounces of water. Under caudal anesthesia the tumor was thoroughly coagulated and a considerable amount of it removed. This was repeated on May 21, June 4, 18, and 28, before it was all resected. The bladder was clear of growth when examined on July 16, 1935, and has remained so, the last cystoscopic examination having been made on February 14, 1936. The various pathological reports showed it to be a benign papilloma.

CASE II. A man was admitted to St. Luke's Hospital on January 23, 1936, complaining of profuse, painless hematuria. For ten years he had had monthly bladder irrigations by his family physician because they helped his arthritis. He gave a history of anginal attacks for four years. His blood pressure was 112/84 in the right arm, 90/76 in his left. Electrocardiogram was "characteristic of diffuse coronary disease with an old occlusion on the posterior surface of the left ventricle." The cardiologist advised against any operative procedure.

Under caudal anesthesia the bladder was found to be full of clots, ten ounces of which were aspirated before the 1 × 1½ inch tumor

* Read before the Section of Genito-Urinary Surgery, New York Academy of Medicine, March 18, 1936.

was visualized on the left lateral wall. Hemorrhage was quickly controlled and the tumor resected in its entirety, when found to be pedunculated. There were no postoperative complications, but a lighting up of his arthritic condition. He was cystoscoped one month later and the bladder found to be free of growth. The pathological report was "no normal structure, but a mass of carcinoma. The nuclei are extremely numerous and hyperchromatic and there are many mitotic figures. The tissue is arranged over a slender vascular core, thus producing a well marked papillary structure. "*Diagnosis:* papillary carcinoma of the bladder."

Case III. A man aged sixty-one, was seen at the Hospital for The Ruptured and Crippled, in April, 1931, because of painless hematuria which necessitated a transfusion. Cystoscopic examination showed a small benign papilloma posterior to the left ureteral orifice, which was promptly destroyed with a Bugbee electrode, using the Wappler teletherm. He was followed for six months without recurrence of the tumor. He returned for examination two years later, when he was asked to submit to a cystoscopy in a New York clinic, because of red blood cells in the urine. Cystoscopic examination at that time, April 11, 1933, showed three papillomata in the region of the left ureteral orifice, two being destroyed promptly with fulguration. The third growth was resistant to electrocoagulation with the teletherm. This tumor was considered beyond control in January, 1934, when the patient was admitted to the hospital. Endoscopic examination under caudal anesthesia showed a very stocky, hard, infiltrating tumor in the base, posterior to the left side of the trigone. Twelve good sized pieces of tissue were resected, and the base was thoroughly coagulated. One month later about the same amount of tissue was removed. This procedure was repeated at monthly intervals until July 21, when the bladder was almost clear. Because of this improvement and a summer's holiday he did not return until October 10, 1934, when the tumor had regained its original size. With this repeated tendency toward recurrence, and in view of the pathological report, the outcome seemed hopeless. However, the same treatment was continued and after six attempts the bladder was free from growth on February 2, 1935. It has remained so since that time, the last cystoscopic examination having been made on March 11, 1936. The pathological report in part, by Dr. Leila C. Knox, showed that "most of the tissue is a diffuse carcinoma with much necrosis and degeneration. There are many large hyperchromatic nuclei Mitoses are very numerous and the tumor is evidently a highly malignant one, a Broder's Grade IV."

SUMMARY

Thus, 3 cases of bladder tumor, resected with the electrotome, are presented, one a large benign papilloma, and two carcinomata—one a Broder's Grade IV, which has been cured locally for one year. All 3 cases were beyond the scope of the former methods of transurethral fulguration.

The 3 cases presented show how the advent of the electrotome broadened the field of electrocoagulation in the treatment of bladder tumors.

DISCUSSION

Dr. Abraham Hyman. The case reported in which the tumor was resected with the electrotome, brings up an interesting question. About two or three years ago Beer first applied this method of treating neoplasms in the bladder, using a flexible loop through the ordinary cystoscope. The first case in which he employed it was a large carcinoma of the bladder situated near the neck and was regarded as a most unfavorable tumor to treat, but we were all considerably surprised at the result obtained for the patient was cured by this procedure. Since then I have had an opportunity to use the method in 2 cases of papillomas of the bladder. They were so situated that it was a very simple matter with the resectoscope to snip out all this tumor in one sitting. Why the type of infiltrating carcinoma should respond to this method of treatment I cannot explain. I doubt if anyone else can give a plausible explanation, because in the cases of infiltrating type of bladder tumor in which the bladder is opened and treated by fulguration, similar to endothermy, the results are worse in that type of treatment that in any other type of treatment. In going over a series of almost 700 bladder tumors and analyzing the

various methods of treatment we found the best results were obtained with resection, where it was feasible, and the next best by a combination of endothermy with radium, but fulguration alone in the open bladder gave poor results. Still a few patients have been presented, one with a definitely infiltrating case of carcinoma of the bladder, cured or arrested by this method.

Dr. Russell S. Ferguson. The report of Dr. Taylor interested me because I just had the opportunity of examining the five-year end results in 658 cases in the Tumor Registry. I think one might say that the treatment of the non-infiltrating tumors of the bladder by any method is apt to result well. In the Tumor Registry, with something over two-thirds of the cases of the papillary variety, the end result after five years, was 34 per cent in the non-infiltrating tumors. These cases were treated by a wide variety of methods by 100 different surgeons in the American Urological Association. On the other hand, in the infiltrating tumor, the five-year end result was 15 per cent, regardless of what method was used. Dr. Alcock and I have used this method, but I do not believe the results will be any better than the variety of results demonstrated in the Registry material. It has long since been known that almost any treatment will suffice for a single papillary tumor that is not true cancer histologically. At least 40 per cent can be cured by simple fulguration.

UMBILICAL CANCER

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AUGUSTA, GA.

CANCER of the umbilicus, whether primary or secondary, is exceptionally rare.[1] The possibilities of primary cancer are greatly limited by an absence of those structures in which cancer originates, inasmuch as the umbilical scar is covered by a very thin squamous epithelium and is devoid of hair follicles, sweat glands and sebaceous glands. Very infrequently remnants of the omphalomesenteric duct have been discovered in the form of small fistulous tracts or cysts, or as small tubular glands opening directly in the umbilical depression.[2] From these very limited possibilities a few cases of Paget's disease and adenocarcinoma have been derived as primary entities.

On the other hand, simple examples of umbilical tumors, papillomas, nevi, mesodermal tumors, and endometriomas are not uncommon. Nevertheless, in one instance, a papilloma was associated with a urachal cyst, in another instance an umbilical adenoma with a patent omphalomesenteric duct, and in 2 cases of umbilical cancer there was an underlying primary gastric carcinoma. The latter 2 cases are reported herein, not merely as a matter of record but also to call attention to the diagnostic challenge which every umbilical tumor conveys.

A. Primary umbilical carcinoma
1. Squamous cell carcinoma
2. Adenocarcinoma

B. Secondary umbilical carcinoma derived from
1. Stomach
2. Gall bladder
3. Intestine
4. Ovaries
5. Uterus
6. Other abdominal organs

The superficial lymphatics draining the umbilicus pass in four directions; those of the upper half of the umbilicus drain into the axillary lymph glands, while those of the lower half empty into the external inguinal group. The deep umbilical lymphatics likewise drain chiefly upward and downward. Those from the upper umbilical region pass on each side of the falciform ligament of the liver, pierce the diaphragm and enter the mediastinal glands. Of especial importance in connection with our report is an additional small lymph channel found along the course of the round ligament of the liver. It is along this channel that cancers of the stomach and gall bladder find their way to the umbilicus. The lymph channels of the lower half of the umbilicus pass downward and empty into the internal inguinal glands.

When a pelvic malignancy forms its metastases in the umbilicus the cells have usually extended along the lymphatics found in the course of the remnants of the obliterated umbilical arteries and urachus. It is to be observed that this extension is retrograde, or against the current, and accomplished by tumor cell proliferation within the lymph channel in a continuous chain. In one of our cases a careful selection of blocks of the tissue from the periphery of the excised mass were taken with reference to the avenues of lymphatic extension and the sections cut longitudinally to these directions to demonstrate this fact. On the contrary, once the umbilicus has become the seat of malignancy, it may then distribute its cells widely, and other groups will appear in the axilla and groins, as in our first case.

CASE REPORTS

CASE 1. Carcinoma of umbilicus, secondary to gastric carcinoma.

A well nourished colored female, aged forty years, was admitted to the University Hospital complaining of general weakness, an umbilical tumor, a distended abdomen and peri-umbilical and pelvic pain. For four months previous to admission she noticed a gradual swelling of the abdomen with enlargement and discoloration of the umbilicus. She had had no digestive disturbance.

Positive Physical Findings. The lymphatic system was negative except for palpably enlarged nodes of the external right inguinal group. A systolic murmur was heard at the aortic area of the heart. The blood pressure was 190/110.

No peripheral edema was evident.

Tremendous uniform abdominal distention with faintly perceptible fluid wave and shifting dulness were present but no masses were palpable.

The umbilicus was smooth, everted, discolored a bluish brown, 3 × 3.5 × 1.5 cms., of firm elastic consistency, with satellite nodules and red brown at the periphery of the umbilical growth.

On pelvic examination the cervix and uterus revealed nothing noteworthy except that it seemed to be involved in a general nodular studding of the cul-de-sac and right fornix.

High up rectally the finger could discover palpable nodules in the rectovaginal septum.

A barium series was studied roentgenographically. "Screen of stomach showed in supine and prone position a moderate enlargement with severe pylorospasm. Very little barium was seen to leave the stomach over a period of about ten minutes. Possibly an organic lesion of the outlet. Film made after fluoroscopic examination showed stomach emptying. Duodenal cap not well visualized but prepyloric area appeared to fill out."

The white blood cells and hemoglobin were about normal but the red cells were diminished to 2,270,000. The urine showed nothing noteworthy.

The patient was obviously afflicted with an internal malignancy and the idea of attempting anything more than a gentle exploration was at once abandoned. Accordingly, on September 16, 1935, the umbilical tumor was excised by an elliptical incision with the aid of infiltration analgesia, and about five litres of serous fluid aspirated. The peritoneum, chiefly the parietal, was seeded with minute grayish white nodules, particularly dense in the cul-de-sac and right side of pelvis. The omentum was sparsely studded with nodules. In the gastrocolic

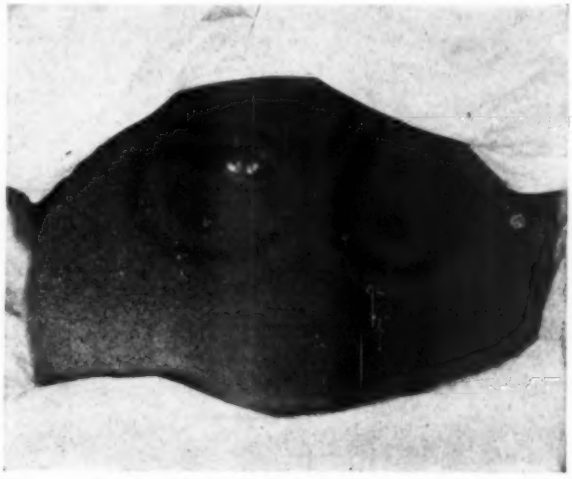

Fig. 1. Case 1. Distended abdomen (ascites) with an umbilical tumor.

omentum near the pylorus were grouped several fair sized nodular masses. A large pyloric tumor situated on the greater curvature was brought into the wound and palpated and a biopsy was taken from the omentum near the neoplasm. One of the right inguinal nodes was excised.

Postoperative Diagnosis. Inoperable carcinoma of the stomach, peritoneal carcinomatosis, ascites, metastatic umbilical carcinoma with metastases in the right external inguinal glands.

The abdominal wound healed by primary union. Ascites accumulated very slowly, the patient gradually failed and died at home four months later.

Pathologist's Report (Dr. E. R. Pund). Sections from the umbilical tumor, omental nodules and the inguinal lymph node showed invasion by a glandular carcinoma composed of atypical acini attempting gland formation. Scattered about the field were large cells filled with mucoid material which stained deeply with hematoxylin but failed to take the mucicarmin stain. The section of the abdominal wall including the umbilicus was 10 × 6 cms.

Diagnosis. Metastatic carcinoma, probably gastric in origin.

Case II. Carcinoma of umbilicus secondary to gastric carcinoma.

A well nourished obese white male, about sixty years of age, was found to have a small umbilical mass with an ulcerated area about one inch in diameter surrounded by subcu-

taneous induration some four inches in diameter. The cutaneous margin of the ulcer was elevated and rounded. About three months previously the patient first noticed an uncomfortable roughening of his umbilicus with some scab formation. His physician applied a caustic which made it sore; then soothing oils, etc., were tried without benefit.

Later it was discovered that the mass was under the umbilicus, not sore or sensitive, but sharp, stabbing pains radiating in all directions from the umbilicus had been frequent during the past two months. Otherwise his health had been good, his weight was 270 pounds with no loss.

The preoperative diagnosis was epithelioma. With the aid of novocain infiltration analgesia the whole tumor bearing area was excised and the primary tumor discovered in the stomach. The peritoneum was apparently clear and there was no ascites.

Postoperative Diagnosis. Adenocarcinoma of stomach with metastasis to the umbilicus.

The patient eventually succumbed postoperatively.

CONCLUSIONS

1. The lymphatic paths of the umbilicus are discussed in the report of two umbilical tumors secondary to gastric carcinoma.

2. The rare occurrence of inguinal metastases in gastric carcinoma, Case 1, is explained on the basis of secondary spread from the umbilical metastases.

3. It is apparent from the report of these 2 cases that tumors of the umbilicus are of profound interest for so frequently they herald the occurrence of disease elsewhere. Each umbilical tumor carries with it a beckoning challenge and the portent of some sinister affliction lurking somewhere in the abdominal cavity.

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NEW INSTRUMENTS

NEW METHOD OF INDIRECT BLOOD TRANSFUSION

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IN the method of indirect transfusion depicted, the advantages are: (1) elimination of anxiety on the part of the patient; (2) simplicity of operation; (3) a closed system, minimizing the chance for contamination; and (4) the time element, reduced to within a half-hour on the part of the operator.

This method has been employed with success at the Charles Godwin Jennings Hospital of Detroit, Michigan, for the past year. All indirect transfusions done in the past are evidence of the feasibility of this method.

The method or procedure is to remove the glass tubing from a Vacoliter bottle, the container of the intravenous medication prepared by the Don Baxter Co., of Glenview, Illinois, and replace it with one of a larger bore. Allow one end to protrude two inches above the rubber stopper and the other end to penetrate beyond the halfway mark of the bottle. Sterilize this bottle with the other equipment needed for the transfusion. For hospital use prepare several such Vacoliter bottles and use them exclusively for transfusions. They need never be taken apart for cleaning or sterilizing.

When the donor arrives, start an intravenous saline on the recipient, using the Vacoliter System. With the arm of the donor prepared, attach a short piece of rubber tubing to the glass tubing protruding from the bottle. With a syringe introduce about 30 c.c. of sodium 2.5 per cent citrate into the Vacoliter bottle via the attached rubber tubing. Insert a large needle into the donor's vein. After a steady stream of blood is assured, attach the free end of the rubber tubing to the needle, holding the Vacoliter bottle below the level of the arm. The blood will flow freely into the Vacoliter bottle. The bottle should be rotated constantly to assure the proper admixture of blood and citrate. Fill a 20 c.c. syringe with citrate and attach a fine needle; insert through the rubber tubing and into the hub of the needle in the donor's vein. The syringe should be gradually emptied, assuring a mixture of blood and citrate as the blood leaves the donor, as this prevents a possible clot in the rubber or glass tubing should the flow of blood be temporarily disrupted. When 500 c.c. of blood are obtained, remove the needle from the donor's vein. Disconnect the needle. Inject several cubic centimeters of citrate into the bottle through the tubing to wash it free of blood and again prevent possible clot formation in the glass or rubber tubing. Disconnect the rubber tubing from the glass tubing. Cover glass tubing and opening in rubber stopper with sterile gauze.

The blood is now ready for the recipient. Remove the gauze from the Vacoliter bottle containing the blood. Clamp the tubing of the Vacoliter intravenous saline in the patient's arm, stopping the flow of saline. Remove the Vacoliter containing the saline from the stand and withdraw the drip chamber. Insert the drip chamber into the unoccupied opening of the Vacoliter containing the blood, invert, and hang up on the stand. Release the clamp and the blood will flow freely into the vein of the recipient.

DISCUSSION

1. We take for granted that the donor has been properly typed and cross agglu-

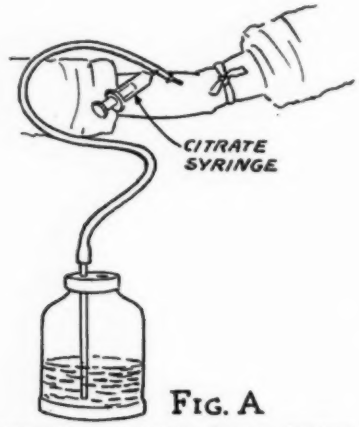

FIG. A
OBTAINING BLOOD FROM DONOR

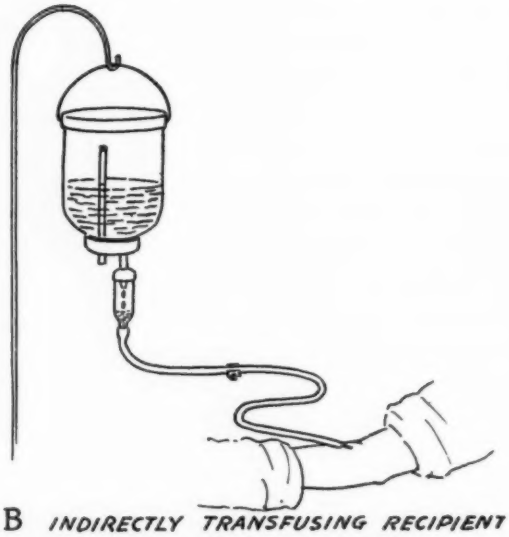

FIG. B INDIRECTLY TRANSFUSING RECIPIENT BY CLOSED VACOLITER METHOD

FIG. 1.

tinated and that his serology is negative.

2. Former methods included a gauze filter. We object to the use of gauze because of the introduction of fine particles of lint into the system. If one insists upon the use of a gauze filter it may be inserted in the glass drip chamber without disrupting the system.

If a clot did form in the system we do not believe it could flow through the usual small sized intravenous needle, instead the system would become blocked and the flow of blood disrupted. In this event the apparatus would have to be taken apart and the use of the old open graduate and funnel instituted. Nothing is lost as the blood may be poured from the free opening of the rubber stopper. Clots form only when the needle is not properly inserted in the donor's vein and the blood does not flow in a steady stream. If the tubing is not immediately washed with citrate by the syringe, the blood en route halts long enough in the tubing to clot. Consequently a good flow of blood should be assured before attaching the rubber tubing to the needle in the donor's vein.

3. A permanent marking at the 500 c.c. level should be placed on the container.

4. When carrying blood from donor to recipient, the container should be placed in a pail containing water at body temperature.

5. Sterilization of bottle. The container should be used for no other purpose than transfusion.

At the conclusion of a transfusion the rubber tubing and drip chamber should be disconnected from the container. The glass chamber and rubber tubing may be washed and sterilized in any chosen method. The container is easily washed by simply connecting a piece of rubber tubing to any water spout which is already intact in all laboratories, and connecting the other end to the glass tubing protruding from the container. Turn on the faucet and the bottle fills and the water spurts out the free rubber stopper opening, assuring a thorough agitative washing. Empty the container and repeat the process, using distilled water placed on a level higher than the container. Empty again and refill with distilled water. Plug the two openings, the glass tubing remaining intact, and leave the bottle filled until ready to sterilize preceding next transfusion.

6. Emergency pack. Sterilization should be performed on the day of the transfusion and include the following items, in a pack for the autoclave:

1. The transfusion bottle described but emptied of the distilled water.

2. Syringe and hypodermic needle for novocaine, if desired for donor.

3. 20 c.c. syringe and one intravenous needle.

4. One large transfusion needle.

5. Tourniquet, towels, rubber tubing for container.

6. Dissecting set if desired.

In addition novocaine 1 per cent, sodium citrate 2.5 per cent, iodine and alcohol should be on hand.

7. More detailed preliminary sterilization may be obtained by first washing the tubing and the glassware in cold water, soaking in 1 per cent lysol solution, rinsing with distilled water, boiling in 1 per cent sodium hydroxide in distilled water for five minutes and then rinsing again with distilled water.

8. The system proved admirable in an emergency on the operating table.

SUMMARY

1. A simple method of indirect blood transfusion is described.

2. The method consists briefly of starting an intravenous Vacoliter saline administration on the patient, drawing the blood from the donor into a prepared Vacoliter bottle, and then substituting the blood Vacoliter for the saline Vacoliter, without removing the needle in the vein of the patient.

3. Possible complications and their avoidance are discussed.

4. Sterilization and care of equipment is described.

5. This method should further the use of blood transfusion for convalescent nutrition and strength rather than its reservation for emergency use.

DEVELOPMENT AND SURGICAL APPLICATIONS OF AN ABSORBABLE TUBULAR MEMBRANE

PRELIMINARY REPORT

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THIS is a preliminary report of the development and manufacture of absorbable tubes made of animal membrane and designed as straight, "T," and "Y" tubes for suggested uses in the anastomosis, suture and reconstruction of ductal structures, especially the common bile duct and ureter. The absorbable tubes are made in graduated calibers, and processed to permit variations in absorption periods.

The literature records an interesting array of materials in a search for a tubular absorbable support for suture and repair of ducts.

Injuries to the common bile duct as a result of accidental trauma are becoming more frequent. Explorations of the common duct are being done oftener. Sullivan and McArthur have advocated common bile duct reconstruction around a soft rubber tube. Giordano and Stropeni reported the use of a segment of vein to fill in the defect in the duct. Experimental work by Horsley threw unfavorable light upon this method. Segments of fascia lata were used by Lewis and Davis with disappointing results. Moynihan suggested the use of the jejunum in the same manner as the gasteroenterostomy of Roux. Molenius proposed the use of the hardened appendix to replace the common duct. Latteri and Pettinari reported the use of hardened guinea-pig's trachea, quills of dove's feathers and magnesium tubes to fill in common duct defects.

In 1923, McArthur reported the suture of a traumatically ruptured ureter over a ureteral catheter. Schapf, in 1887, made the first attempt to unite a divided ureter in man. From the early work it was apparent that urine, escaping at the site of the suture, caused marked scar tissue formation and that the contraction of scar tissue produced stenosis of the ureter. Hinman* has tried using magnesium and modified gelatin tubes with unsatisfactory results.

In 1886, Postempski, of Rome, succeeded in closing a lateral wound of a femoral artery and thus inaugurated the modern method of suture, with the first successful arteriorraphy in man after Lambert's case. Matas followed in 1888 with suture of a traumatic aneurism of the brachial artery. The active interest of modern surgery was not aroused until J. B. Murphy, in his classic paper of 1897, demonstrated that end-to-end anastomosis was feasible. Payr, in 1900, described a method of circular arteriorraphy with magnesium rings as a provisional support. Carrell's technique of circular arteriorraphy has been confirmed and found to be the method of election.

Absorbable catgut strands have been used as wicks. Decalcified chicken bones and quills have been used in draining cerebral abscesses.

SUGGESTED USES FOR ABSORBABLE TUBES

Several months ago, it occurred to me that an absorbable animal tubular membrane could be made which would facilitate the technical procedures in duct surgery and processed to permit variation in absorption time. The suggestion was communicated to a suture manufacturer,† with

* Personal communication.

† Davis & Geck, Inc.

the result that an absorbable tube made from catgut was evolved.

The following surgical situations suggest themselves where an absorbable tube, permitting splintage of suture line, drainage of secretions through a patent lumen and absorbability, might be utilized to facilitate surgical technique:

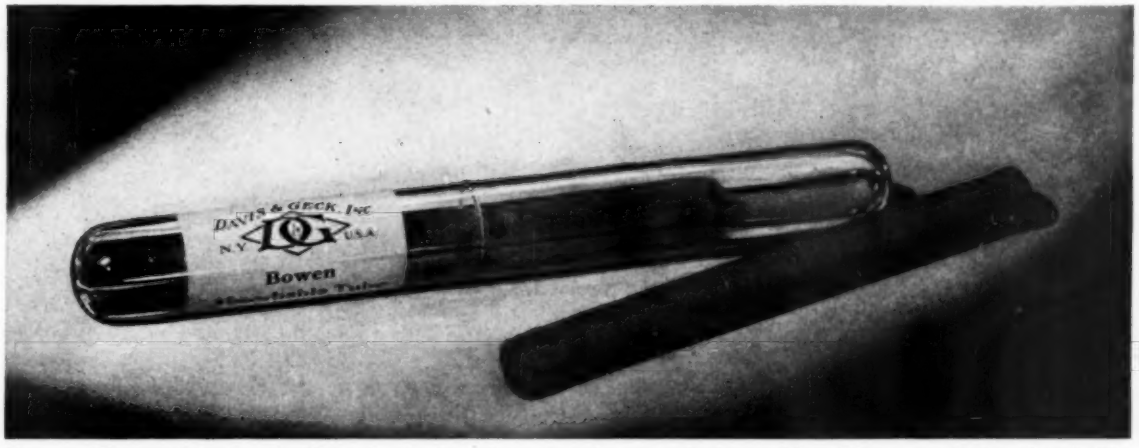

Fig. 1. Shows the absorbable tube in its glass container, and along side of it, one of the absorbable tubes removed from the container.

I. Biliary Tract. 1. End-to-end anastomosis of strictured or severed common duct over implanted straight or "T" absorbable tube;

2. Tight suture of wound following exploratory choledochotomy with implantation of the tube to remove tension on the suture line, prevent too tight a suture and stricture, and biliary fistula;

3. Use of the tube as a structural support over which to build and reconstruct the duct with surrounding tissues;

4. End-to-end anastomosis of hepatic to common duct over implanted tube; and

5. To facilitate transplantation of common duct into (a) duodenum, (b) stomach, (c) jejunum, (d) colon, using the implanted straight or "T" tube for direct implantation or by means of the Coffey technique.

II. Urology. 1. End-to-end anastomosis of cut or strictured ureter over implanted tube. The development of an absorbable tube over which to anastomose a cut or strictured ureter appears to meet the requirements of (a) simple technique, (b) splintage of suture line, (c) patent lumen to permit urinary flow, (d) absorbability;

2. Tight suture after ureterotomy;

3. Uretero-intestinal anastomosis implanting a sufficient length of the absorbable tube in the lumen of the transplanted ureter to maintain its patency during the period of traumatic swelling following its embedment in the wall of the intestine;

4. Plastic surgery of the urethra by implanting the tube as a tunnel through which to maintain urinary flow and over which as a support to reconstruct the wall of the urethra; and

5. Plastic reconstruction of cut or stenosed vas deferens.

III. Gynecology. 1. Plastic reconstruction of a strictured lumen or fimbriated end of the Fallopian tube to maintain patency; and

2. Reconstruction of the remaining uterine end of the Fallopian tube after removal of a tubal pregnancy from the distal portion.

IV. Vascular Surgery. End-to-end anastomosis of veins, arteries and lymphatic ducts.

V. Orthopedics. Placing a sutured tendon in the lumen of a lubricated absorbable tube to prevent adhesions of sutured tendon to surrounding structures, to permit the

tendon to lie and move in a tunnel of the absorbable tube and the creation of a residual tunnel of surrounding tissues after the tube has been absorbed.

VI. Neurosurgery. To deposit a sutured nerve within the sheath of the absorbable tube to prevent adhesions.

VII. Salivary Ducts. Transplantation, drainage and dilatation of the salivary ducts.

VIII. Drainage Tubes. An absorbable tube of animal membrane is suggested for use in draining abscesses where one fears losing a nonabsorbable drain.

SUMMARY

The literature reveals numerous attempts to utilize some form of absorbable hollow structure in ductal surgery, but without complete success. Herein are recorded the development and many suggested surgical applications of an absorbable tubular membrane, made of varying absorbability and of various shapes and sizes. Experimental work on the mentioned surgical applications is in progress and the results will be published in a subsequent paper.

The author wishes to express his appreciation to Davis & Geck, Inc. for their cooperation.

NEW INSTRUMENTS IN PLASTIC OPERATIONS ON RENAL PELVIS AND URETER

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TO those familiar with the surgery of the kidney the illustrations shown with legends are self-explanatory. The whole idea of the instruments is to minimize the amount of actual gross injury to the kidney substance in plastic operations, where a catheter "splint" is employed to advantage and also where nephrotomy drainage, in addition, is indicated.

To the late Dr. Charles H. Peck[1] belongs the credit for introducing the idea of "splinting the ureter" by catheter in operations upon the pelvis. The writer has referred to this advantage in a previous paper[2] and has employed it with much satisfaction during the past eight or nine years. Little reference has been made by others to Dr. Peck's method excepting in recent publications.

We have found the instruments herewith presented very useful and helpful during the past two years. Heretofore, surgeons have usually employed the ordinary hemostat to perforate the kidney parenchyma in order to establish drainage from the pelvis. With the jaws opened, the usual hemostat spreads considerably within the kidney and causes an unnecessary laceration of the substance. We have noted, furthermore, that the fistulous wounds of the kidney, after removal of the catheter "splint" or drainage tube, appear to heal more quickly. In fact, some wounds have failed to drain any urine in the loin following the removal of the catheter "splint."

The use of the instruments presented gives the operator an added feeling of confidence, particularly where the ureter is amputated and end-to-end suture to the pelvis employed. With the ureteric catheter lying in position, as illustrated, for five to seven days after operative repair, it is apparent that canalization of the lumen is more efficiently maintained and that distortion, kinking and stenosis at the ureteropelvic junction is prevented during the earlier stages of healing. Nephrotomy drainage with catheter offers the advantage of reducing tension and increased pressure of urine on the pelvis and suture line and meets the factor of possible associated infection. It appears to be as logical to divert the urinary stream in certain of these cases as in cystotomy when plastic operations are done on the urethra. Nephrotomy drainage is much preferred to pyelotomy drainage.

It has been shown by Iselin,[3] in animals, that eversion of the mucous membrane of the ureter is the chief factor in causation of late stenosis after healing. The removal of any redundant portion of mucous membrane is, therefore, necessary in end-to-end suture. The work of Iselin tends to revolutionize previous conceptions concerning the late effects on kidney function, of complete division of the ureter. Further experimental work in this field is most essential and necessary. These matters have been more fully discussed in a recent contribution.[4]

We believe the instruments shown herewith are of practical value and will facilitate successful end-results.

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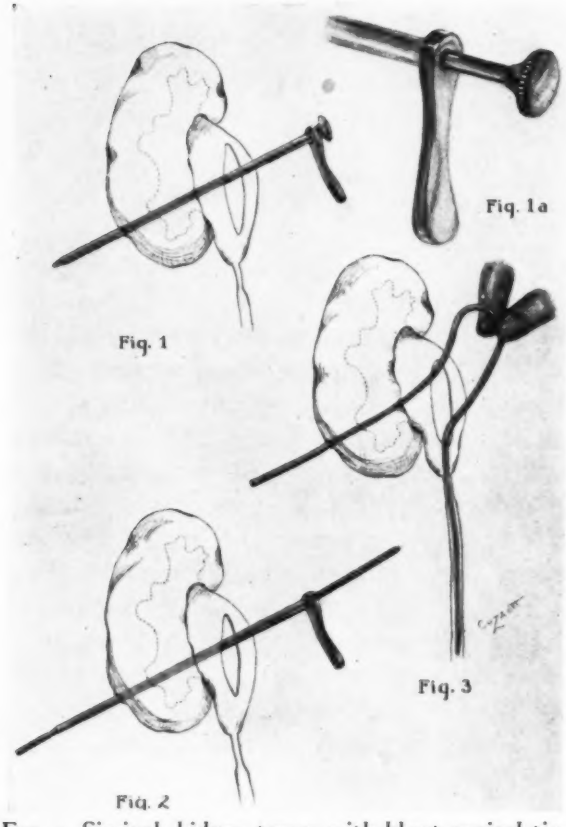

Fig. 1. Six-inch kidney trocar with blunt conical tip introduced through incision in pelvis and forced through kidney substance at external border by way of lower calix; provides minimum trauma to renal substance.

Fig. 1a. Detail of kidney trocar with handle, obturator partially withdrawn. The instrument is made in two sizes, one to admit a No. 6 F. silk catheter or bougie, the other to admit No. 8 F. catheter or bougie.

Fig. 2. Obturator of kidney trocar completely withdrawn, with No. 8 F. silk catheter passed through lumen beyond handle.

Fig. 3. After the removal of the trocar, distal end of No. 8 F. catheter is passed well down the ureter near bladder, while the proximal end is brought out through the upper angle of wound. This provides adequate "splinting" of ureteropelvic juncture and avoids distortion and stenosis at site of plastic procedure.

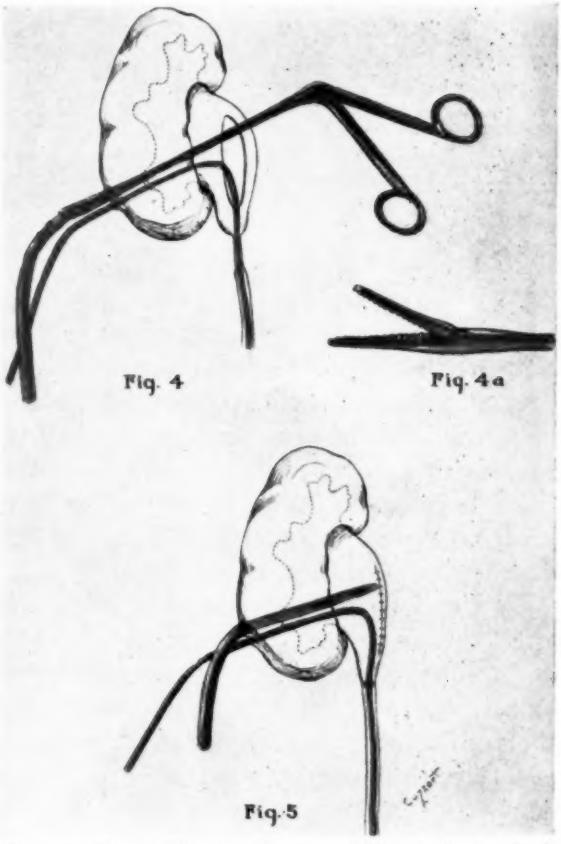

Fig. 4. New alligator forceps with six-inch shaft forced through kidney substance in manner similar to a trocar. No. 16 F. four-eyed rubber catheter, held in jaws of forceps, about to be drawn into cavity of renal pelvis. This minimizes kidney trauma when providing nephrostomy drainage.

Fig. 4a. Detail of alligator forceps with jaws open. Maximum caliber of forceps at hinge No. 16 F. Jaws always closed tightly when passing through kidney substance.

Fig. 5. Plastic operation of ureteropelvic junction completed, including partial resection of redundant pelvis; nephrostomy drainage tube and "catheter-splint" in proper position. (Proximal ends brought out through incision.) "Catheter-splint" remains in situ for five to seven days. Nephrostomy drainage tube, advisable in all anastomotic procedures and often in other repair cases, remains in situ for five to six days.

[From Fernelius' Universa Medicina, Geneva, 1679.]

BOOKSHELF BROWSING

SHORT HISTORY OF STOMACH SURGERY

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THE history of surgery of the stomach is also the history of surgery in general. There were famous and wonderfully skillful surgeons before the middle of the nineteenth century; men who were preparing the way for the remarkable advances in surgery made possible by the discovery in this country of nitrous oxide and ether anesthesia by Long, Wells and Morton in 1844–1846, and James Simpson's use of chloroform in Scotland in 1847. These, with Lister's demonstration of the bacterial cause of infection in 1860–1870, and the subsequent development of antisepsis and asepsis, so revolutionized surgery that it has made most marvelous progress in the past sixty years.

Hippocrates (400 B.C.) is considered the first scientific physician; he opened the door to modern medicine by breaking away from the mysticism, superstitions and dogma of his day, and recognizing and teaching that disease and health were both governed by natural laws which could be learned by observation and experience. Whether the humoral theory was propounded by Hippocrates is not known, but during his time disease and health were explained as being a proper or an improper distribution of blood, phlegm, yellow bile and black bile. This theory was assumed later by Galen (130–200 A.D.). Gradually it was enlarged and expanded, and with remarkable ingenuity, used to explain all natural phenomena, until finally nothing remained of Hippocrates' once scientific method. Galen's system of medicine was taught and practiced until the eighteenth century, his influence being but slowly overcome by such men as Andreas Vesalius (1543) the anatomist, Ambroise Paré (1510–1590) who rediscovered ligatures, and William Harvey who discovered the circulation of the blood in 1628.

Anatomy had been studied from the time of Vesalius by such men as Fallopius, Eustachius and Sylvius who all helped to establish it on a sound basis. Physiology was not understood, and certainly that of the stomach was not known until 1833, when William Beaumont published the results of his work on Alexis St. Martin in his famous "Experiments and Observations"[4] and settled all arguments as to whether the stomach was "a mill, a stew pan or a fermenting vat" (Wm. Hunter, 1628).

Beaumont's work is too well known to enlarge on it, but some of his findings might be mentioned. He proved that the gastric

juice is a factor in digestion instead of a diluent, as had been believed till this time. He showed that hydrochloric acid is secreted by glands in the stomach and that this secretion is started by eating and smelling food, and that digestion is hindered by emotion, worry and alcohol. In fact very little has been added to the knowledge of the physiology of this organ since his time.

Pathological conditions in the stomach were thought to begin with "dyspepsia" which was caused by overeating, as no doubt it was quite frequently in those days. Inflammation was supposed to be the next step in the pathology and ulcers formed if the inflammation did not clear. Sometimes these ulcers bled, perforated or developed into a fungoid or a dense scirrhus growth. All were thought to be progressive stages of one condition and were not differentiated until Cruveilhier[11] distinguished ulcers of the stomach from cancers. He wrote, "Concerning simple chronic ulcers of the stomach. Confused in practice sometimes with chronic gastritis, sometimes and more commonly with cancer, simple chronic ulcer of the stomach does not appear to me to have attracted the attention of observers as a special disease."

In 1828, Dr. John Abercrombie, of Edinburgh,[1] wrote a very interesting book which gives one an idea of what was known at that time. Under the heading "Pathology of the Stomach" he lists the following chapters, illustrating them with cases which he had studied.

Progress and Termination of Chronic Gastritis.

1. Succession of small ulcers of the lining of the stomach. Fatal by gradual exhaustion.
2. Circumscribed ulceration with thickening. Fatal by gradual exhaustion.
3. Extensive ulceration with thickening, complicated with remarkable disease of the omentum and peritoneum, fatal by gradual exhaustion.
4. Ulcer of the stomach. Fatal by haemorrhage.
5. Simple ulceration of very small extent. Suddenly fatal by perforation of the stomach.
6. Perforating ulcer of the stomach and communication with the arch of the colon.

Treatment at this time[8] consisted of liberal bloodletting, topical application of leeches, free purgation, simple diet of farinaceous foods, lime water and milk, and abstinance from liquors. This treatment had been found to be successful in cases which evidently were due to ulcer and so was used for everything. Occasionally cold applications were tried, which was fortunate if the pain happened to be in the right lower quadrant. These patients could seldom be helped, but died in agony, relieved only by heroic doses of alcohol and morphine and copious bleeding.

Anesthesia was not discovered until 1846, but it was several years before it came into general use. It was more than twenty years later, in 1870, when Lister, following Pasteur's lead, so revolutionized surgery as to eradicate bacterial contamination of wounds, and this with the aid of anesthesia made it possible to enter the abdomen deliberately, without haste, and to close the wound with the expectation of having the incision heal by first intention. Of this decade, 1875–1885, Stephen Smith[32] of New York wrote in 1885,

> Formerly everything was subordinated to celerity in operation. Now mere haste is mentioned but to be condemned. Recovery without suppuration is the end sought. Perfect cleanliness and thorough antisepsis of operation, assistants, patient, instruments and dressings are required, by the use of, (1) soap and water to the external parts, (2) carbolic solution for all instruments, (3) bichloride solution for all surfaces and tissues, (4) iodoform for all dressings. All this in contrast with the disregard for cleanliness formerly in vogue. Sponges are elaborately purified, the ligatures are aseptic, and not expected to "come away." Drainage tubes are used as a temporary expedient if at all, no suppuration being expected, and the lips of the wound being brought by deep and superficial sutures into complete apposition.

All this brings us to the latter part of the nineteenth Century, which is the time that

the "History of Surgery of the Stomach" really begins. Needless to say there was not a leap from complete ignorance to complete knowledge. Gastrotomy for foreign bodies is very old. Crolius,[31] is said to have removed a knife as long as 1602. Guenther, in 1613, also is said to have done this operation. In 1837, Egebert of Norway, first suggested gastrostomy for stricture of the esophagus, and it was first performed by Sedillot in 1846. All these cases died. Gastrorraphy was first done for an injury by Wolfler, a Bavarian, in 1521, and Billroth in 1877, was the first to do it for a fistula. Loreta,[15] in 1882, suggested and practiced dilation of the pylorus (pylorodiosis) by the fingers, but after several deaths from hemorrhage and perforation this was dropped.

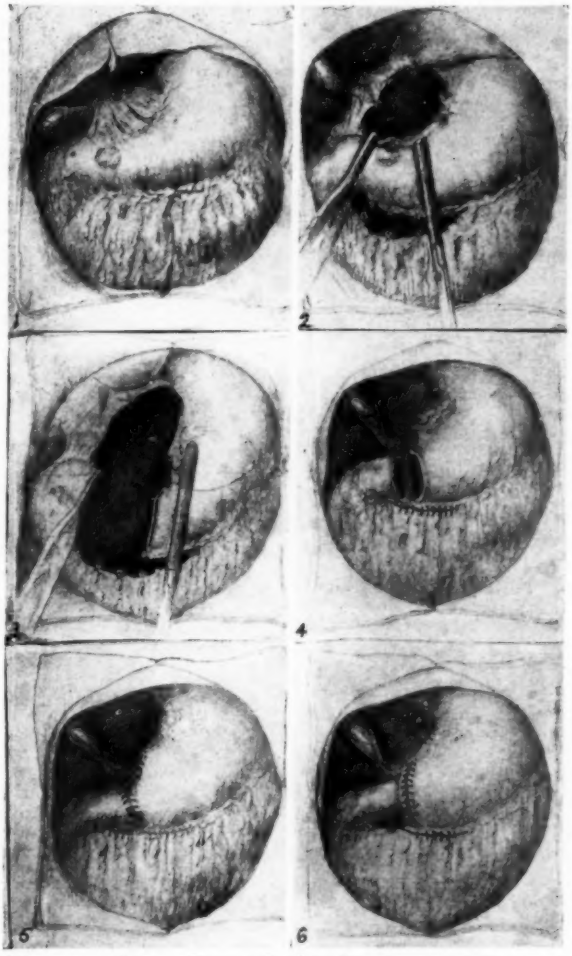

Plate I. Fig. 1. Stomach showing a cancerous area. Figs. 2, 3, 4, 5. Showing the method of doing a Billroth 1. Pean was the first to try a pylorectomy in 1879, but Billroth was the first to do one successfully. Fig. 6. Kocher's operation. Because of an occasional failure from leakage at the lower angle of the anastamosis, Kocher suggested that the stomach be closed and the duodenum inserted into the posterior wall of the stomach.

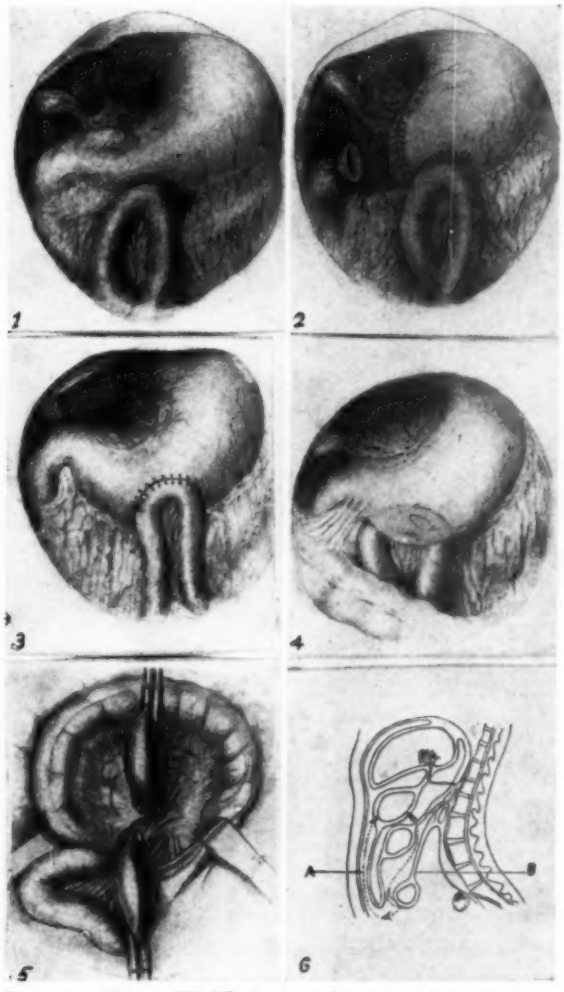

Plate II. Fig. 1. Wolfler's anterior gastroenterostomy, performed first in 1881. Fig. 2. A Billroth II. A gastroenterostomy has been performed and the tumour removed. If the duodenum cannot be approximated to the stomach the duodenum and stomach are closed and the duodenum allowed "to act as an enlarged bile duct." Fig. 3. An anterior gastroenterostomy with the anastomosis made isoperistaltic-Rockwitz, 1887. Fig. 4. Showing Von Hacker's posterior gastroenterostomy, 1885. Fig. 5. Performing a posterior gastroenterostomy. The stomach and transverse colon are turned upward and an opening made in the mesocolon through which the jejunum is attached to the posterior wall of the stomach. Fig. 6. Diagram to show the direction in which the jejunum is taken for (*A*) an anterior gastroenterostomy, and (*B*) a posterior gastroenterostomy.

Pyloroplasty for pyloric stenosis was done as early as 1886–1887 by Heineke and Mikulicz.[31] A. C. Bernays, of St. Louis,[5] in operation was again worked out by Gussinbauer and Winiwater, and again later by Czerny and Kaiser who also suggested the

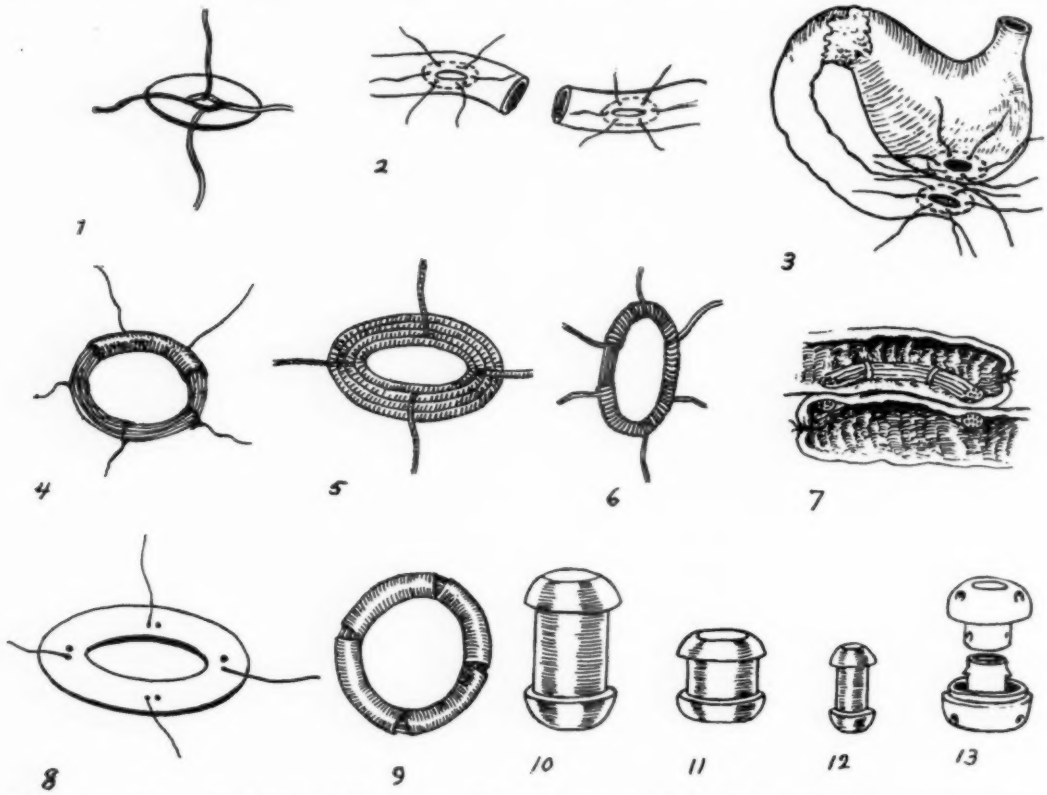

Plate III. Fig. 1. Senn's decalcified bone plate. Figs. 2, 3. Method of performing anastamoses with Senn's plates. Fig. 4. Abbe's catgut ring, made of heavy catgut thread. Fig. 5. Davis' catgut mat. Fig. 6. Matas' solid catgut ring, made of boiled drumsnare. Fig. 7. Sagital section of an intestinal anastamosis showing the position of these rings and plates. Fig. 8. Davis' solid catgut plate. Fig. 9. Brokaw's ring, made of hollow rubber segments (drainage tube) threaded with catgut strands. Figs. 10, 11, 12. Robson and Moynihan's decalcified bone bobbins. Fig. 13. Murphy's button.

1887, tried curetting cancerous growths, but as soon as the pathology of cancer was better understood this procedure was discarded. Some of these operations undoubtedly have a place in surgery, but they assume a minor role compared to those of pylorectomy, gastrectomy and gastroenterostomy.

The need for some operation to relieve pyloric obstruction had been recognized for years, and as long ago as 1810 Merrem and Ganther[23,31] showed that dogs could live without parts of the stomach. However, anesthesia and aseptic surgery had not yet been discovered and so it was impossible to repeat this procedure on human beings. In 1876, however, this feasibility of the procedure on humans.

Thus the stage was set for Dr. Pean of Paris[31] when, in 1879, he was besought by a patient who was suffering from the pain and starvation of a pyloric obstruction to do something for his relief. He removed the cancerous pylorus, however, with a fatal ending, and although the operation was considered "a piece of surgical audacity" Rydygier tried it the next year, also with a fatal result. On January 29, 1881, the famous Theodor Billroth of Vienna was the first to do a successful pylorectomy, and his patient lived for four months before dying of recurrences.

This operation, since known as the Billroth 1, consists of removing the pylorus

with its pathology and suturing the duodenum to the lower angle of the stomach incision and then closing the rest of by anastomosing the jejunum to the anterior surface of the stomach at the greater curvature, thus short circuiting

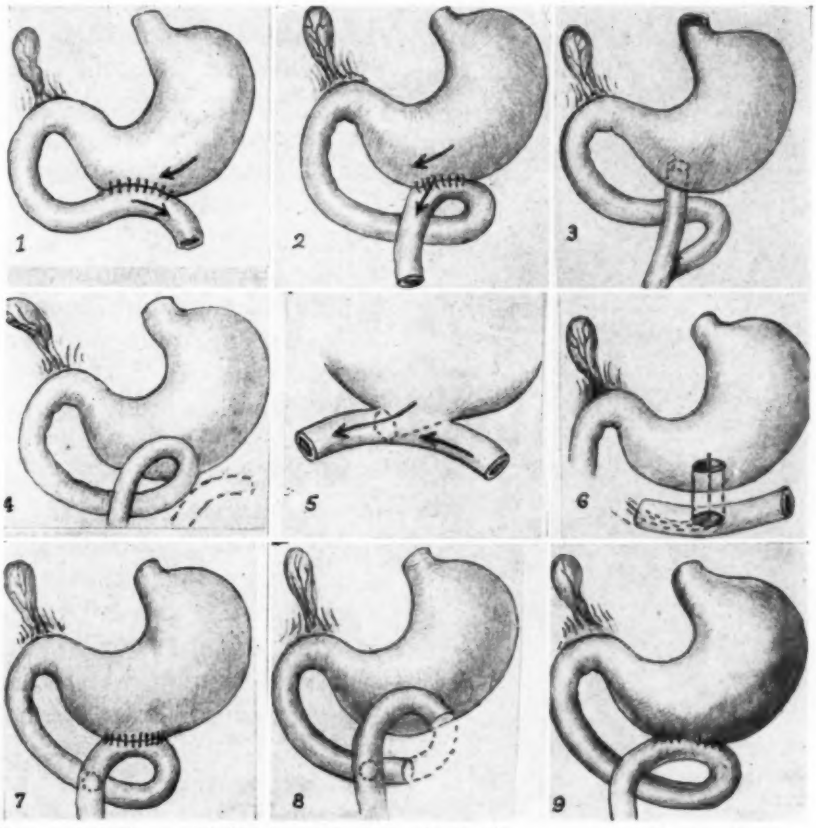

Plate iv. Fig. 1. Wolfler's original method. The current in the duodenum is antiperistaltic to that in the stomach. Fig. 2. The isoperistaltic method of Rockwirtz. Fig. 3. Roux's Y method, posterior. Fig. 4. Launstein's method. Fig. 5. Faure's method of "gastroenterostomy by invagination." Fig. 6. Sonnenburg's method of "gastroenterostomy by invagination." Fig. 7. Braun and Jaboulay's operation. An entero-anastomosis between the afferent and efferent loops. Fig. 8. Doyen's Y method. Anterior gastroenterostomy with a side to side entero-anastomosis. Fig. 9. Hadra's suspension of the loop to prevent spur formation.

the opening in the stomach. (Plate 1.) Occasionally a leak developed at the angle of the closure of the anastomosis and Kocher suggested inserting the duodenum into the posterior surface of the stomach. (Plate 1. Fig. 6.)

This operation apparently settled the problem of pyloric stenosis, but on September 27, 1881, Anton Wölfler of Vienna, found a pylorus so bound down by adhesions to the pancreas[28,32] that it was impossible to remove the tumour. Following the suggestion of his assistant, Nicoladoni, he performed the first gastroenterostomy the stomach contents around the pyloric obstruction. (Plate II. Fig. 1.) Wölfler's patient lived about four months before dying of the cancer.

Billroth at first removed the tumour mass and then if possible he united the duodenum and stomach. Before 1885 he improved this operation and the patient's chances by performing a gastroenterostomy before trying to remove the tumour, and if it was not possible to unite the duodenum and stomach he would close the ends, allowing the "duodenum to act as an enlarged bile duct."[17] This method became

known as Billroth's Second Operation. (Plate II, Fig. 2.)

These early gastroenterostomies were all performed by bringing the jejunum to the anterior surface of the stomach, in front of the transverse colon, and occasionally the jejunum or the colon would become obstructed, or the weight of the colon on the jejunum would tear out the anastomosis. In 1885 Von Hacker suggested and performed the first posterior gastroenterostomy[23,31] by bringing the jejunum through the mesocolon to the posterior surface of the stomach. With the introduction of the posterior method we find the operation of gastroenterostomy done essentially as it is done today. (Plate II. Figs. 4, 5, 6.)

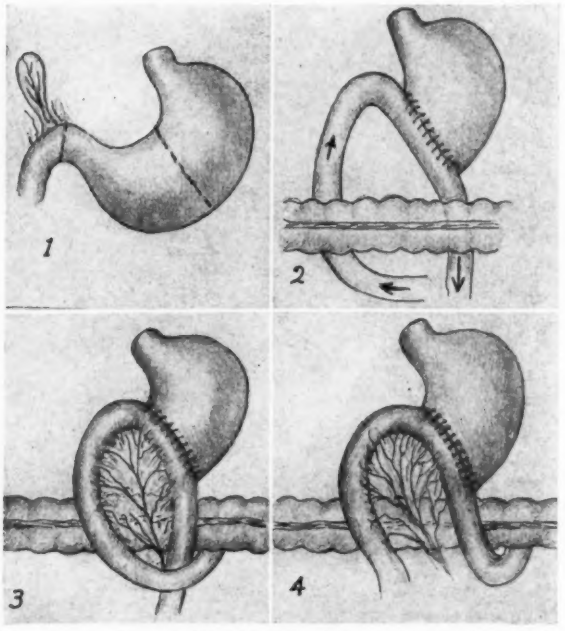

PLATE V. Fig. 1. Showing the lines of resection. The amount removed may be less than that shown here or may be increased up to a total gastrectomy. Fig. 2, Polya's operation. The jejunum is brought through the mesocolon and attached to the stump of stomach along the whole line of excision. Fig. 3. Balfour's modification of Polya's operation. The jejunum is brought in front of the transverse colon. Fig. 4. Moynihan's modification.

The news of the success of these operations soon spread and in 1885 R. Winslow published a "Statistical Review of the Operative Measures Devised for the Relief of Pyloric Stenosis."[34] In it he studies the 60 operations done in various parts of the world up till that time. He found a mortality of 75 per cent except for the cases done by Billroth and his pupils, Czerny, Mikulicz, Wölfler and Von Hacker who had a mortality of only 55 per cent. Winslow lists the following operation which were used at that time for stenosis of the pylorus: "Pylorectomy, Gastroenterostomy, Gastrectomy, Gastrostomy, Duodenostomy and Digital divulsion of the pylorus." He also lists these three indication for operation:

"1. Carcinoma with unendurable pain, or stenosis with threatening starvation.

"2. Ulcers producing stenosis with starvation.

"3. Stenosis following the swallowing of a caustic lye."

These patients were usually almost moribund, needless to say, before submitting to the operation and the high mortality is not surprising. In his summary Winslow states that a patient with a carcinoma which is not producing stenosis should not be operated upon, as pylorectomy and partial gastrectomy are attended by too high a mortality. In other cases of carcinomatous stenosis, as only very temporary relief can be obtained, a gastroenterostomy should be done. He also said that union of the stomach and duodenum or jejunum may be performed in one of three ways,

1. Immediate suture of the cut ends. (Billroth I.)

2. Suture of the stomach opening; implantation of the duodenal cut end into the posterior surface of the stomach. (Kocher.)

3. Closure of both openings and performance of a gastroenterostomy. (Billroth II.)

By 1898 however, the technique of operations on the stomach had improved to such an extent that Mikulicz[31] was able to point to a mortality rate of 27.8 per cent in resections of gastric ulcers; 16.2 per cent in gastroenterostomies, and only 13.2 per cent for pyloroplasties. He said that this rate was bound to improve and Time has demonstrated the truth of his forecast.

Until this time the anastomoses had all been done by interrupted sutures of gut or linen and the number of stitches taken and the time required for the operation were all recorded. In an effort to reduce this time Senn in 1887, introduced perforated bone plates[29] around which the anastomosis could be made more rapidly. Numerous other methods were tried, (Plate III) such as Davis' catgut mat, the solid catgut ring of Matas and Robinson's rawhide plate,[27] also Robson and Moynihan's well known decalcified bone bobbins and Murphy's famous button.[24] These aids undoubtedly cut down the time required but greatly increased the morbidity of these operations,[23] as most of these foreign bodies had to slough out and frequently left a raw ulcerating stoma which contracted down and often caused so small an opening as to be useless, while sometimes a new ulcer developed in the jejunum. When A. C. Bernays returned from Europe in 1890, he foretold the fate of these devices and reported that the surgeons there were discontinuing these aids to intestinal anastomosis as they appeared to be getting better results with the simple Lembert suture.

Besides the difficulties with the stoma narrowing, signs of obstruction in the afferent or efferent loop often developed. In the search for the explanation of these occasional failures numerous modifications were developed. Rockwitz in 1887 first drew attention to the fact that in Wölfler's operation the current in the stomach was opposite in direction to that in the duodenum. He suggested that the anastomosis be made isoperistaltic. (Plate IV.) Other methods were suggested and tried, such as Roux's Y method; Braun and Jaboulay, Doyen, Kocher, Moynihan, Mayo and many others developed variations. Even pulling a pouch of the stomach into the intestinal loop was tried, as well as several methods of narrowing the lumen of the afferent loop to prevent it from filling. Wölfler surrounded it with a circular stitch, Chaput packed it with iodoform gauze, Von Hacker made a series of longitudinal pleats in it; the loop was shortened in the belief that a long loop allowed kinking. Hadra in 1891, suggested that the loop of bowel be attached to the stomach above and below the stoma; all these without greatly improving the results of the operation.

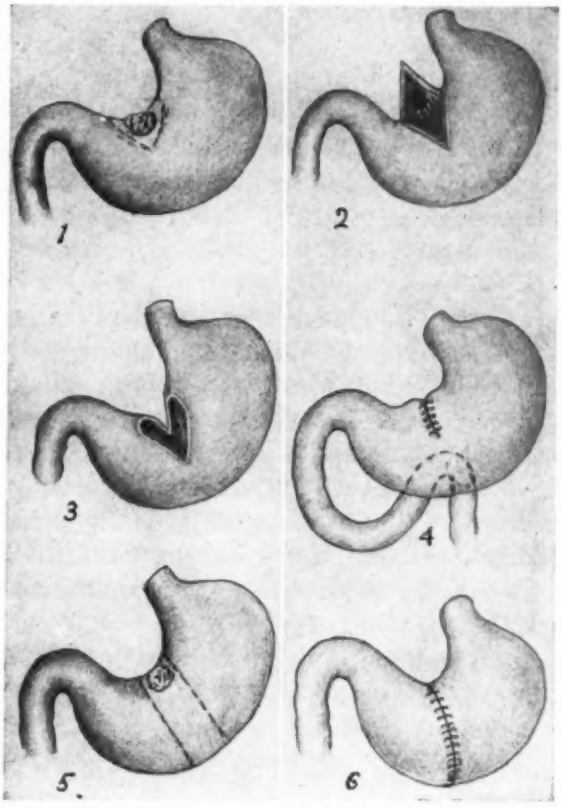

Plate VI. Figs. 1, 2, 3, 4. Rydygier's wedge excision of an ulcer. Figs. 5, 6. Sleeve resection. A complete circular section or cylinder of stomach is removed with the ulcer. This operation seems to interfere with the peristaltic waves less than a wedge excision.

Undoubtedly some of the trouble was due to kinking of the loop, but mostly to the fact that the stoma was too small or became too small by the contraction of the scar tissue after the bone plate or bobbin or Murphy button had sloughed out. Three factors have contributed to the success of the gastroenterostomies done in these times as compared with the earlier operations, namely

1. The stoma is made larger, from 2½ to 3 inches in length, and is placed near the greater curvature, preferably in a vertical

position, so there is no pouch below the opening. (Mayo, Moynihan.)

2. The sides of the incision in the mesocolon are sutured to the stomach so as to prevent constriction of the loop of bowel, the loop of jejunum being made long enough to allow free play.

3. The use of absorbable continuous sutures on atraumatic needles instead of nonabsorbable sutures being used with foreign bodies such as plates, bobbins and buttons.

By 1893, Doyen was doing a posterior gastroenterostomy for simple ulcers with good results; in 1895, Hartmann first used it on a case of hematemesis, and in 1902, Kronlein of Zurich and Von Mikulicz of Breslau after a thorough study of the value of different operations in malignancy of the stomach reached the conclusion that, (1) cancer of the stomach, without operation, terminates fatally in about one year; (2) gastroenterostomy prolongs the life of the patient about three months; (3) and gastrectomy prolongs the life of the patient about fourteen months.

The year before, in 1901, A. T. Cabot[9] speaking of peptic ulcers, wrote "that gastrotomy, excision of ulcers, gastroplication, pylorectomy and pyloroplasty have very limited uses. Gastroenterostomy, however promotes healing of the ulcer and stops haemorrhage even when the ulcer cannot be found." He gives these indications for surgery,

> Acute haemorrhage should rarely be treated by surgery as results have rarely been good, while medical treatment has.
>
> When however, the haemorrhage repeats itself, if so severe as to endanger life or to cause anaemia, operate.
>
> Perforation, either acute with general peritonitis, or chronic with surrounding adhesions and perigastritis, operate.
>
> Chronicity, recurring frequently and diminishing the patient's capacity to work or live, operate.

Thus as more and more operations were performed statistics became increasingly available and the true value or worthlessness of the various operative procedures began to come to light.

This brings us to modern times. Roentgen discovered the *x*-ray in 1895 and its possibilities were immediately recognized, and the need for it is shown by the large number of papers published within two years of Roentgen's discovery. Although H. P. Bowditch suggested using the roentgen-ray in the study of gastric motor function in 1896, W. B. Cannon[10] was the first to record his scientific investigations. He presented his paper before the American Physiological Society in 1897, and it was published in 1898. Cannon used cats in his work and he wrote that "the mixing of a small quantity of subnitrate of bismuth with the food allows not only the contractions of the gastric wall, but also the movements of the gastric contents to be seen with the Roentgen ray."

The investigators in *x*-ray work are almost too numerous to mention, but anyone interested in the history of *x*-ray would be well rewarded by reading "The Science of Radiology."[12] Williams apparently was the first to suggest using an opaque substance, bismuth subnitrate, in diverticula of the esophagus. Lead and mercury was first employed in gastric diagnosis but was encased in a sausage skin because of its ill effects. In 1896 Kemmeter first used plumbic acetate and later bismuth in a rubber tubing which did little more than outline the greater curvature. Williams and Leonard, in 1897, first showed the outline of the stomach with barium. Cannon mixed the barium with food in his experiments, while Cole was probably the first to use milk or buttermilk and was thus able to demonstrate more clearly the irregularities of the stomach. Mills, Case, Rieder, Reigil, Holzknecht, Cole, Carman and many others have all added something to the art of *x*-ray diagnosis which has steadily and rapidly improved until today it is one of the most reliable aids in the diagnosis of gastric pathology.

The immediate interest taken in the *x*-ray is evidence of the need or desire to see inside the patient's stomach. This need is also shown by the history of the gastroscope.[14] As long ago as 1868 Kussmaul persuaded a goodnatured sword swallower to allow him to pass a tube down the esophagus into his stomach. The illumination was so poor, however, that little or nothing could be seen. In 1879, Nitze, after perfecting his cystoscope, turned his attention to gastroscopy. His results were poor also. Mikulicz, 1881, was the greatest of the early exponents of gastroscopy and his instrument was an improvement over the earlier ones, as by reflecting light down the tube he was able to see more clearly. In 1905, Chevalier Jackson greatly improved gastroscopy by adding a filament light to the distal end of the tube. Some very ingenious instruments have been tried, such as a jointed tube which can be straightened when it has been passed into the stomach. Several have been bent at various angles, and even one is very cleverly segmented so that the segments are extended one by one. However the pain and distress caused by passing one of these instruments is sufficient to deter even the boldest. It is hard or impossible to pass if the patient's teeth are present, so hard in fact, that it has been suggested[18] that a few teeth be extracted to enable the operator to pass the tube. The danger of perforating the esophagus or crushing it against the vertebral column is a very real danger and deaths have occurred from these causes even in the best hands. The area which may be seen is very small compared to the rest of the stomach and although there are some noted enthusiasts of gastroscopy, most surgeons feel that the passing of a gastroscope is more dangerous than a laparotomy and that the gain is not worth the danger and pain to the patient.

The principle of transillumination of hydroceles was applied by Einhorn[18] to the examination of the stomach. The instrument, called a gastrodiaphane, consists of a small, powerful electric light in the end of a flexible rubber tube. The tube was passed down the esophagus into the stomach which was filled with water. In a darkened room an indurated or cancerous area on the anterior surface showed as a dark shadow in the midst of the illuminated stomach. Kemp felt that he got 50 per cent more illumination by using a fluorescent medium such as bisulphide of quinine or florescine dissolved in the water with which the stomach was filled. Even photography has been tried. In 1930, Beck,[2] of Vienna made a small powerful camera which he called a gastrophotor, for taking pictures of the interior of the stomach. It is small enough to pass down the esophagus without much discomfort, but the pictures are very small and show only a very limited area and require an extensive experience to be read and interpreted correctly.

However none of these methods can compare with the roentgen-ray in the visualization of stomach pathology, and even the *x*-ray film is inferior to actual exploration and inspection of the parts, since an exploratory operation can be done with practically no mortality. When the abdomen is opened the operation best adapted to the condition present may be performed at once, and other pathological conditions, such as gall-bladder disease or appendicitis may be corrected at the same time.[23]

For years gastroenterostomy was the most popular operation for obstruction of the pylorus. Pylorectomy and gastrectomy were, and still are, followed by a high mortality. Patients came late to operation and relief from their distress or starvation was all that was expected. Therefore a gastroenterostomy sufficed for those inoperable cancers of the pylorus where short circuiting was all that could be done. A gastroenterostomy is ideal for the average duodenal ulcer, either acute or chronic, but recent accumulating evidence shows that this is not sufficient for

ulcers high on the lesser curvature and many surgeons, particularly in Europe, are advocating a partial gastrectomy of

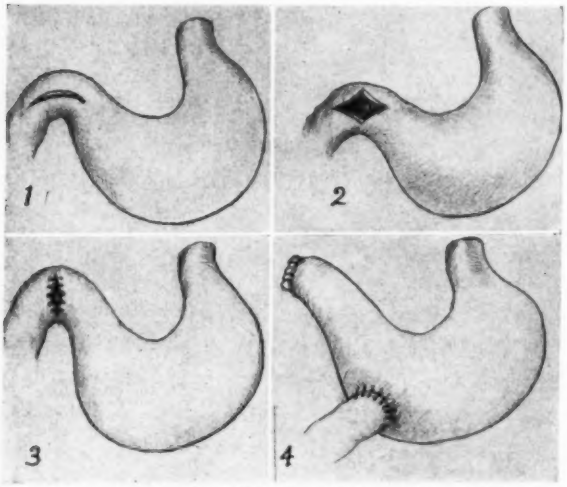

Plate vii. Heineke-Mikulicz Pyloroplasty. Fig. 1. Incision made in the pylorus. Fig. 2. Incision spread apart and Fig. 3 sutured so that the lumen of the pylorus is widened. Fig. 4. Kummell's method, a gastroduodenostomy.

this ulcer bearing and acid secreting portion of the stomach, to prevent a recurrence of the old ulcer and the development of new ones in other parts of the stomach or around the stoma. This complication of gastrojejunal ulcer, which was first described by Braun in 1899, is not seen as frequently, but does occur in a small percentage of cases, especially in those which show a large amount of free hydrochloric acid. Local excision of these ulcers is very unsatisfactory as a large percentage develop recurrences. The best operation appears to be that of a partial gastrectomy, and this must be extensive enough to include most of the acid secreting portion of the stomach, or a marginal ulcer may appear even with this operation. The operation itself is very difficult, as the old anastomosis has to be undone and the continuity of the duodenum and jejunum left unimpaired. If a long loop, 2 to 3 inches, has been left at the time of the original operation, the jejunum may be anastomosed with the stump of the stomach with comparative ease according to the Polya method, with the proximal end of the jejunum at the lesser curvature. If the loop is short, it may be necessary to attach the proximal end at the greater

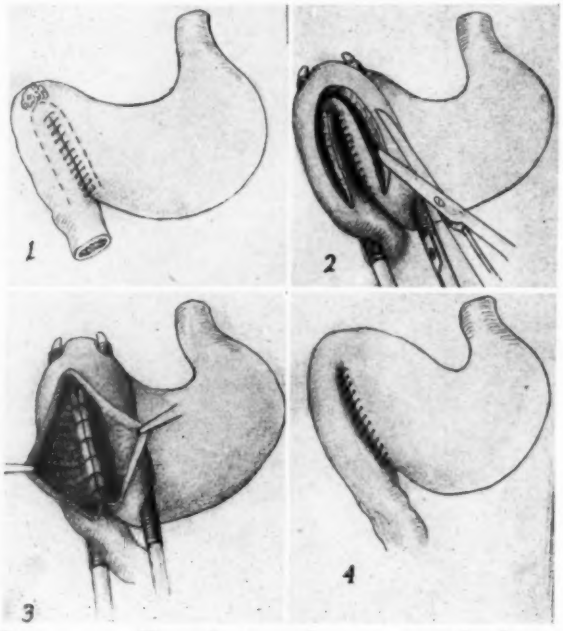

Plate viii. Finney's operation; a gastroduodenostomy. Approximation of the stomach and duodenum is hard or impossible when swelling, edema or adhesions are present.

curvature.

The difficulty encountered in performing these operations would seem to be an argument in favor of doing a partial gastrectomy for all ulcers of the stomach. This however is hardly justified, for as A. J. Walton[33] says "the combined mortality of simple gastroenterostomy in the treatment of pyloric and duodenal ulcers, and partial gastrectomy for the few cases that develop a gastrojejunal ulcer is considerably lower than that of a routine partial gastrectomy."

The first partial gastrectomies by Pean, Rydygier and Billroth were done for cancer of the pylorus and the mortality of the operation was very high; so later a gastroenterostomy was frequently used for cases where a partial gastrectomy should really have been done. For these cases of cancer at or near the pylorus a Billroth I may be done when the stomach and duodenum can be brought together; or a Billroth II when the resection is so great

as to make a Billroth I impossible. In 1911, Polya[26] published his technique for an operation which had also been independently evolved by Sherren in 1910,[30,33] which was a decided improvement over a Billroth II in extensive resections of the stomach. With it a very wide resection is possible, even to a total gastrectomy. The cut end of the stomach is completely anastomosed to a loop of jejunum which is brought up through an opening in the mesocolon. This method has shortened the operating time and has eliminated the possibility of a devitalized lower angle which sometimes occurred in the stump of the stomach in a Billroth I. Balfour and Moynihan[23] have modified Polya's operation by bringing the jejunum anterior to the colon. Balfour attaches the jejunum so that the proximal end of the jejunal loop is at the lesser curvature of the stomach. Moynihan's method is less complicated in that there is no twisting of the jejunum upon itself. He attaches the proximal end of the loop at the greater curvature. (Plate V.)

Several other operations should be mentioned, although they are indicated very infrequently. Rydygier[31] performed the first excision of an ulcer in 1881, removing a wedge of stomach which included the ulcer. (Plate VI.) If the ulcer is large, a sleeve of the stomach which includes the ulcer may be resected and the healthy edges apposed to form a somewhat shortened stomach. Infolding the ulcer, especially if it looks as if it might perforate, or destruction with the cautery is frequently combined with a gastroenterostomy.

Pyloroplasty for stenosis of the pylorus was first done by Heineke in 1886 and by Mikulicz in 1887 to replace Loreta's method of digital divulsion. Their method is strictly a pyloroplasty as the pyloric lumen is enlarged. (Plate VII.) The other modifications are more correctly called gastroduodenostomies since the duodenum is anastomosed to the stomach. In 1894 Jaboulay reported his method of doing a gastroduodenostomy. A small section of the anterior surface of the duodenum was folded over and united with the anterior surface of the stomach. In 1895 Kummel divided the duodenum, closed the proximal end and united the distal end to the anterior surface of the stomach. In 1902 Finney[28] improved these methods. He first united the stomach and duodenum with the first layer of sutures and then made an extensive horseshoe shaped incision through the stomach and duodenum, thus practically eliminating the pylorus. (Plate VIII.) Finney's operation is the most correct anatomically and the least disturbing physiologically of any of the operations devised for relief of pyloric stenosis. Also, Moynihan says, he has never seen an ulcer recur after a gastroduodenostomy by Finney's method. However it has several disadvantages which limit its use; it cannot be used where the ulcer is large or active, as the swelling and edema hinder the healing of the wound. Dense adhesions may prevent the folding over of the pylorus which is necessary to get union. The convalescence of the patient is not as smooth as with a gastroenterostomy.

A posterior gastroenterostomy is very successful in ulcers of the stomach and particularly so in duodenal ulcers. If conditions permit, a Finney may be done. Where excision is required a Billroth I is indicated if the duodenal stump can be united to the stomach, and a Billroth II or a Polya if the excision is more extensive. If some reason, such as a thick or fat laden mesocolon or adhesions, prevents passing the jejunum through posteriorly to the colon it may be brought anteriorly to the colon by one of the other methods such as Moynihan's or Balfour's. These several operations are the most common in use today, the choice being indicated by the pathology present and modified as the operator sees fit or has found by experience to give him the best results.

There is still, however, a feeling of uncertainty or incompletness in this field of surgery, and Urban Maes laments this

fact in his report on the Symposium on Peptic Ulcers of the American Surgical Society in 1931, when he says "that medical treatment has a definite field, but results are not permanent. There is an element of risk, and the correction of other lesions is not possible. Gastroenterostomy gives excellent results in duodenal ulcers, and only slightly less for gastric ulcers. Gastrectomy has a high mortality even in good hands."

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BOOK REVIEWS

DISABILITY EVALUATION. PRINCIPLES OF TREATMENT OF COMPENSABLE INJURIES. By Earl D. McBride, B.S., M.D., F.A.C.S. 374 illustrations; art work by Herbert Chezam. Philadelphia, J. B. Lippincott Company, 1936.

We venture the opinion that the large majority of those who actively engage in "compensation" work will eventually own a copy of Dr. McBride's excellent work. It fills a large void in this field of surgery and it is more than welcome.

In his preface the author writes, "The purpose of this volume is to interpret the physiological and mechanical alterations arising out of injury to the motor structures of the human body, and to reasonably appraise and evaluate the extent of functional loss as it relates to the economic incapacity of the injured." In his book of 623 pages, including the Index, the author adheres closely to his thesis. Many will not agree with the author in his methods or conclusions of arriving at his percentages, but (to quote Dr. McBride), "it is hoped the reasoning used will be a helpful influence."

Chapter One is devoted to Workmen's Compensations Laws. The following chapters deal with Standardizing Disability Evaluation Methods, Examination of the Disabled Person, Ankylosis (this chapter considers total and incomplete ankylosis, types amenable to treatment, and physical therapy) and there follows chapters devoted to ankylosis of the various joints, as shoulder, elbow, wrist, fingers, hip, etc.; The Disability of Fractures, and a consideration in the following chapters of fractures of various bones, as the clavicle, scapula, humerus, forearm, pelvis, femur, etc.; The Industrial Back, Nerve Injuries, Amputations, Head Injuries, Injuries of the Eye, Injuries of the Ear, Burns, and Hernia.

The reader will find the illustrations of unusual value.

A needed book, which is well written and temperate; it deserves a large circulation.

A SHORT PRACTICE OF SURGERY. By Hamilton Bailey, F.R.C.S. (Eng.) and R. J. McNeill Love, M.S., F.R.C.S. (Eng.). Third edition. With 763 illustrations of which 88 are coloured. London, H. K. Lewis & Co., Ltd., 1936.

This book was brought out in 1932 and in January, 1935, a second edition was offered to the profession. This edition was reprinted in July. And now, a year later, a third edition is published. The authors tell us that this edition has been necessary because "surgery still makes such rapid strides that deletions and additions have been necessary in practically all the chapters."

The authors cover the common and fundamental conditions in detail but have relegated to small type the advanced and rare conditions, "so that the candidate for a qualifying examination can rapidly review essential facts by confining himself to the material included in the larger print."

Personally, we enjoy writings by English authors and "A Short Practice of Surgery" did not disappoint us. The style is clear, comprehensive and to the point. The illustrations are above average, and the coloured illustrations are both plentiful and are beautiful topographically.

It goes without saying that this book of just less than a thousand pages would be a find for the senior medical student or interne, but many full fledged surgeons would find a perusal of its pages solid reading.

MINOR SURGERY. By Frederick Christopher, S.B., M.D., F.A.C.S. With a foreword by Allen B. Kanavel, M.D., F.A.C.S. Third edition. With 709 illustrations. Philadelphia, W. B. Saunders Company, 1936.

Dr. Kanavel in his foreword utters the truism, "There is no greater field for good surgery than is presented by minor surgery, and Dr. Christopher has done the profession a real service in emphasizing the competent care of this group of patients."

Books are printed and the majority, at best, have their brief day and are then forgotten; perhaps it is best that this is the way of publishing. Now and then a work of the first magnitude is offered the profession, followed in the course of time by several editions. One day it is acknowledged to be the standard work on that particular topic. And this is true, with-

out any exceptions, of Dr. Christopher's work now offered in its third edition.

Suffice to say that if you who read this appreciation pretend to do those surgical procedures that have a low mortality and are, for the most part termed "minor," by all means own a copy of Dr. Christopher's book, if you already do not have a copy on your library shelves.

There is no need to go into detail regarding the contents. In this work of over a thousand pages, Dr. Christopher has covered the field thoroughly. The illustrations truly illustrate and have not been thrown in for decorative purposes.

If our praise seems extravagant it is because we honestly believe that this book should be in many hands, and, to date, is the most valuable and satisfactory book we have on this subject.

ORTHOPAEDIC SURGERY. By Walter Mercer, M.B., CH.B., F.R.C.S. (Edin.), F.R.S., (Edin.). With a foreword by John Fraser, Regius Professor of Clinical Surgery in the University of Edinburgh. Second edition. Baltimore, William Wood & Company, 1936.

Originally, the first edition of this recognized work was the result of a response to many requests that a permanent form be given to the series of lectures and clinics on orthopedic subjects which Walter Mercer gave under the direction of Professor Fraser. Concerning the second edition, the author states, "In the preparation of the manuscript for this edition I have endeavored to add to the text the more important developments in the subject . . . which have appeared since the publication of the first edition. . . . I have profited by the criticisms—both kindly and adverse—with which the first edition was greeted."

This work covers the subject in detail. To one interested in the subject the reading is delightful. The illustrations are numerous and well selected.

Naturally, this work, by an outstanding figure in this surgical field, will have an appeal almost exclusively to those who specialize in this branch of surgery. General surgeons who include parts of this specialty in their domain might well study the pages of this book; and the man who limits his work to orthopedic surgery, if he is not familiar with Mercer's work, will not regret adding it to his library.

A TEXT-BOOK OF HISTOLOGY: ARRANGED UPON AN EMBRYOLOGICAL BASIS. By J. Lewis Bremer, M.D. Fifth edition of "Lewis and Stohr," 455 illustrations, 36 of which are in color. Philadelphia, P. Blakiston's Son & Co., Inc. 1936.

Prof. Bremer has done well in revising and bringing up to date, this fifth edition of the well known work of Lewis and Stohr.

Dr. Bremer writes, "The increasing vitality of the embryological and histological sciences within the last few years seems to require a rather radical revision of this text-book with the incorporation of much new material." From this point of view this textbook has been rewritten.

Prof. H. L. Weatherford has written a short section on "the use of stains," which replaces the former one on "microscopic technique." Prof. George R. Minot has provided the new drawings of "blood," and Dr. Henry Jackson, Jr., has drawn the "bone marrow" and aided in writing that part of the text.

The illustrations are many, new illustrations were borrowed from various publications, or are original. There is an ample index.

An excellent textbook which we hope will continue to be in wide use among undergraduates in medicine.

ANORECTAL MUSCULATURE

BY

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New York City

AMERICAN JOURNAL OF SURGERY, Inc.

NEW YORK · MCMXXXVI

THIS WORK WAS DONE AT THE ANATOMY LABORATORY OF NEW YORK UNIVERSITY MEDICAL COLLEGE, BY COURTESY OF PROF. H. D. SENIOR. THE CADAVER PREPARATION WAS DONE BY MR. EWALD OLAFSON.

ANORECTAL MUSCULATURE

CHAPTER I

HISTORY

GALEN (129–200 A.D.) wrote in his De Sedis Musculis

Concerning the muscles of the seat; single, round, and transverse. Stretches the rectum and closes it, extends up to the middle part of the bone which Greeks call Coccyx, and on both sides indeed it ends in the origin of the penis. Moreover, the external opening of the anus has a muscle plus skin and that outer opening of the anus is formed of muscle plus skin called labia. The result is that we may call it a muscular skin or cutaneous muscle. Indeed, it is similar in value to the sphincter of the bladder without being exceeded in strength and firmness of action. There are two other membraneous muscles which are located above the round muscle. Inside of the pubis and laterally toward the sacrum and on both sides they are inserted obliquely and draw the rectum upward with vehement desire and efforts to defecate. It draws the same farther out, propelling and everting the same.

Vesalius and the artist John Calcar of Clive, in their epochal work, de Humani Corporis Fabrica (1543), gave to anatomy its first illustration, now extant, of the anorectal musculature. (Plate 1.)

Riolan, (1580–1657), physician to Queen Marie de Medici, described in his Anatomia more muscles in the anorectal region than was the accepted teaching of Galen. Cowper (1694) wrote in his Myotomia Reformata

Of the Muscles of the Anus. The penis, together with the bladder of the urine being removed, the muscles of the anus offer themselves. Anatomists have not agreed in their number—Galen divides the sphincter into two, viz. Carnofus and cutaneous which with the two levators make four muscles belonging to this part. Riolan multiplies them to the number of nine—three sphincters, namely Carnofus or the Outermost, Cutaneous or the Middle and Vaginalis or the Superior and Innermost, and Six elevators—Two internal and four external. But this opinion seems rather grounded on Fancy, or some particular subject, than a general appearance of them in

DE RECTI INTESTINI MVSCVLIS.

Caput LI.

RECTI inteſtini portio cũ ſuis muſculis à corpore reſecta, quã dũ reliqua eximimus inteſtina, in corpore adhuc relinquere ſolemus.

A Rectum inteſtinum, quod in libri quinti tabulis euadet conſpicuum, præſertim autem octaua figura & uigeſima ſecunda.

B, C Duo muſculi, inteſtinum poſt egeſtionem ſurſum trahentes.

D Muſculoſa ſubſtantia penis radici adnata, in mulieribus porrò ad infimam pudendi partem commiſſa.

Inſuper D ſedes notatur, à qua in penem muſculi duo pronaſcũtur.

E Circularis muſculus, ne præter arbitrium excrementa deijciantur præcauens.

PLATE 1.—Photostat from Andreae Vesalii Bruxellensis. de Humani corporis Fabrica de Necti Intestini Musculis. 1st edition 1543. Concerning the Muscles of the Intestinal Rectum.

Part of the intestinal rectum, whose muscles, resected from the body, from which we removed the rest of the intestine, which hitherto used to remain in the body.

A. The intestinal rectum.

B, *C*. Two muscles, drawn from below, after the intestine was voided.

D. Muscular material connected with the penis root, in the female further forward, joined to the lowest part of the sex organs.

Above *D* the sedes muscle is drawn, from which the two muscles are borne towards the penis.

E. A circular muscle which prevents the excrement present from being ejected outside.

Dissection. Sphincter Ani. This is a large thick fleshy muscle encompassing the anus. Its figures and series of fibers externally, immediately under the skin, incline to an oblong oval; It is connected forward to the accelerator urinae—Backward to the Os Coccygis. As it continued farther upon the body of the Intestinum rectum. Its fibres are circular for nearly Two inches in breadth; It is much larger in man than in other animals, in whom by reason of the erect position of the body, there is greater force required to retain the faeces, which is the office of this muscle.

Santorini, in 1715, identified the three divisions of the external sphincter, and divisions of the pelvic diaphragm. His illustrations are remarkably accurate.

Cruveillier, in 1843, in his article on the levator muscle writes, "in passing the sides of the rectum it would appear that some of the fibres of the levator interlace with the longitudinal fibres of the rectum and continue with them; but this has often appeared doubtful to me."

Kohlrausch, in 1854, called attention to a thin stratum of longitudinal muscular connective tissue between the sphincter internus ani and its mucous membrane. He called this the sustentator tunicae mucosae. He stated that the longitudinal and levator fibres ran together through the external sphincter ani. (Plate 2.)

Beraud, in 1858, reported his studies, begun in 1849, on the termination of the longitudinal fibres of the rectal wall. He traced them from the colon to the skin and anal lining, through the sphincteric musculature. He stated that the levator fibres descend with the terminal fibres of the longitudinal muscle to the skin. His work is the first clear description of the termination of the longitudinal fibres of the rectal wall.

Rüdinger, in 1873, gave his conception in a highly schematic cross section. (Plate 3.)

The first article with illustrated cross sections of the anatomy of the anorectal canal was by Robin et Cadiat (Plate 4) and appeared in 1874, and was followed by Roux in 1881, (Plate 5), Laimer in 1884, (Plate 6) and Holl in 1897 (Plate 7).

PLATE 2.

Cross section of the os sacrum with the coccyx. *C.* Bladder. *D.* Rectum. *F.* Prostate. *K.* Corpora cavernosus of urethra. *M.* Puboprostatic median ligament with the underlying plexis venosus of Santurini. *a.* Folds of inferior rectum. *b.* Lower S shaped rectal curve. *c, c.* Internal anal sphincter. *d, d.* Brush shaped diffusion of longitudinal fiber layer of the rectal muscle between the internal and external anal sphincter. *e.* External anal sphincter. *f.* Muscle fibers of the longitudinal muscle layer of the rectum reaching over to the transverse deep muscle of the perineum. *g.* Muscle sustentator of the mucosa of the tunic. *h.* Region of the orifice of the bladder. *k.* Insertion of the lower end of the muscle detrusor urinae among the fasciculi of the muscle sphincter vesicae in a brush-like formation.

PLATE 2.—Photostat from Kohlrausch, Otto. Zur Anatomie und Physiologie der Beckenorgane. 1854.

Holl (1897), writing in Bardeleben's anatomy, gave a complete critical historical review of the literature, and presented the anatomy of the pelvic outlet with exhaustive descriptions, profusely illustrated by cross sectional drawings.

In the contemporary literature, clinical interpretations of fissure and fistula-in-ano based on the conception of the anorectal anatomy of these historical references were offered by Hiller in 1931, and Milligan and Morgan in 1934. Gorsch in a recent article commented on the importance of the anatomical considerations in surgery of fistula-in-ano.

PLATE 3.—Photostat from Rüdinger. Topographische chirurgische Anatomie des Menschen. 1873.

Lower right cross section through the end of the rectum. 1. Mucous membrane. 2. Skin curving into the canal. 3. Fat. 4. Bundle of levator ani. 5. Sphincter externus ani divided into groups. 6. Radiating bundles of the longitudinal fibers of the rectum which have gone through the sphincter externus ani. 7. Sphincter ani internus. 8. Longitudinal muscle of rectum. 9. Longitudinal muscle in sphincter externus. 10. Fibers which go into the fat. 11. Ring fibers of muscularis of recti. 12. Muscle bundles of the muscularis mucosa which go through sphincter internus. 13. Muscularis mucosa. 14. Arch of longitudinal fibers under sphincter internus.

PLATE 4.

FIG. 1.—Longitudinal section of the anus of a subject about fifty years old. *g*. Rows of glands at the end of the rectal mucosa. *b*, *a*. Point where these follicles end, and where inclining from top to bottom, *b*, one sees the last inclining in the opposite direction, or nearly so, *a*, numerous small veins lying underneath raising the mucosa when the veins are distended. *a*, *c*. Terminal mammillated portion without follicles at the end of the mucosa, 4 or 5 mm. in length, covering the prismatic epithelium with more or less short cells. *b*, *c*. Terminal swelling giving an indent to the appearance to the termination of the mucosa underneath the creases, *a*, *c*. It now has the texture of cutaneous derma, and of pavement epithelium which covers it; it fluctuates, if one can describe it thus, only on a level with the creases of the anus; but on a level with the columns which separate them, it is rounded and projects less. There is always a rounded swelling, but clearly cut from the sides of the rectum in vigorous subjects of both sexes. *b*, *n*. External, or anal surface of this swelling. *b*, *n*, *l*. Smooth soft portion of the skin, extending for 12 to 15 mm., having no or very short papilla. *l*. Part of the skin where papilla begin to be brought nearer and where the epidermis becomes tenacious, resistant, to the layer of Malpighian pigment. *d*. Part of the skin 18 to 20 mm. from the swelling, *b*; there are seen the first hairs of the anus with their sebaceous glands. In this entire region, *b*, *n*, *l*, *d*, there are no sebaceous nor sudoriparous glands nor others in the male. *p*. Sudoriparous glands appear a little farther than the hairs. *m*. Course of the mucosa and the underlying cellular tissue rich in veins. *i*, *o*. Internal sphincter in its connection with the end of the rectum, *b*, and with the beginning of the skin, *b*, *n*, following circular fibers, *i*, of the rectum. In vigorous subjects its inferior extremity advances, *o*, between the skin and the corresponding extremity of the external sphincter, where it is slightly inflated from the side of the skin, but without even touching the latter, a little of the cellular tissue of which separates it. *r*, *j*. End of the anal levator formed by striated fasciculi. *k*, *v*. Cellular and adipose tissue between the levator, *k*, and the sphincter, *v*. *q*. The derma (cutaneous). *r*. Internal surface of the levator between whose fasciculi depart oblique cellular fibers, traversing the longtudinal tunic. *f*. Fasciculi, rising like the preceding ones, among the striated fasciculi of the levator to attach themselves to the posterior surface of the longitudinal tunic. *s*, *t*, *u*, *v*. Section of the external sphincter perpendicular to the direction of its fibers showing the manner in which the flattened muscle is folded back, from *t* to *u*, and embraces, reascending, *v*, the inferior part of the longitudinal muscle layer and the circular, or internal sphincter, muscle layer. *t*, *u*. Refolded or bent portion of the external sphincter, among the fasciculi of which pass, with their cellular tissue and many elastic fibers, the fasciculi of the longitudinal fibers, *t* which are inserted in the skin. The part, *t*, *u* does not represent the inferior edge of the sphincter, but its inferior circumference. *v*. Edge of the superior circumference of the external sphincter. *s*. Inferior edge of the external sphincter refolded and ascending towards the inferior edge of the internal sphincter, *o*; it remains there, always 2 to 5 mm., divided by cellular tissue, adipose or not, blood vessels, and very fine nerve fibers.

PLATE 4.—Photostat from Robin et Cadiat. Journal d'Anatome et de la Physiologie, PL. XXII, 1874. Mucosa and Sphincters of the Anus.

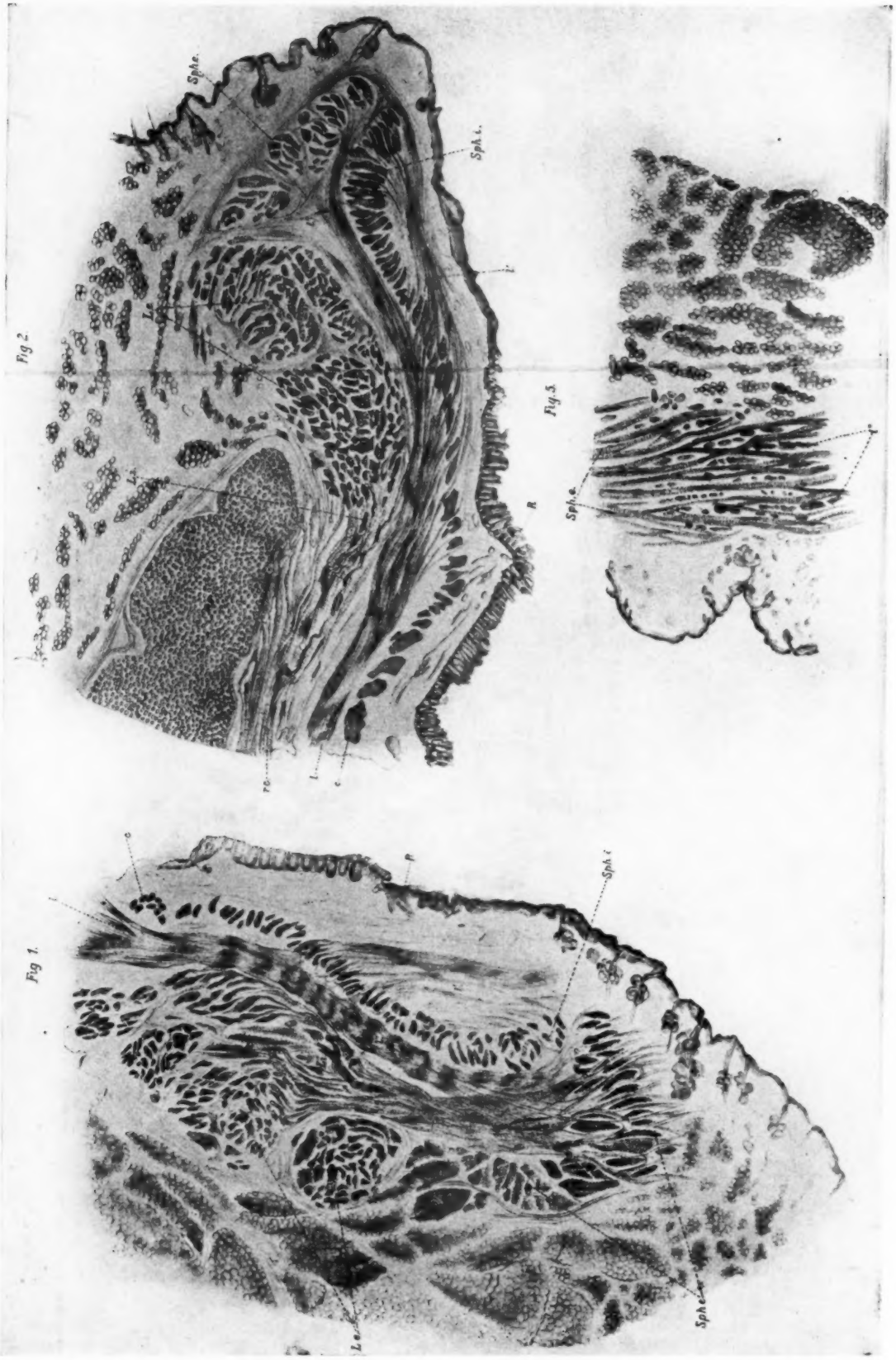

PLATE 5.—Photostat from C. Roux. Archiv für mikroskopischen Anatomie. Con-
R. Mucous membrane of the rectum. *Spb.i.* Internal sphincter. *Spb.e.* External sphincter. *Spb.e'.*
of longitudinal fibers of the rectum with the internal sphincter, *l'*, and the external sphincter, *l''*. *c.* Layer

Fig. 1. Frontal section of the rectum. Fig. 2. Posterior sagittal section of the rectum. *O.c*, coccyx, *rc.* rectococcygeal muscle. Fig. 3. Horizontal layer of the external sphincter.

tribution to the knowledge on the anal muscles in man. Taf. XXXII, XXXIII. 1881
Cutaneous layer of the latter. *L.i.* Inner layer of the anal levator. *L.e.* Outer layer of the anal levator. *l.* Layer of circular fibers.

Fig. 3. Anterior sagittal section of rectum in a young girl; *v*, vagina. Fig. 4. Anterior sagittal section of rectum in a young boy; *u*, urethra, with the longitudinal muscle layer. *C.c.* corpora caver nosa (bulbus) of the urethra; *bc.* muscle bulbocavernosus; *r.u.* muscle rectourethra.

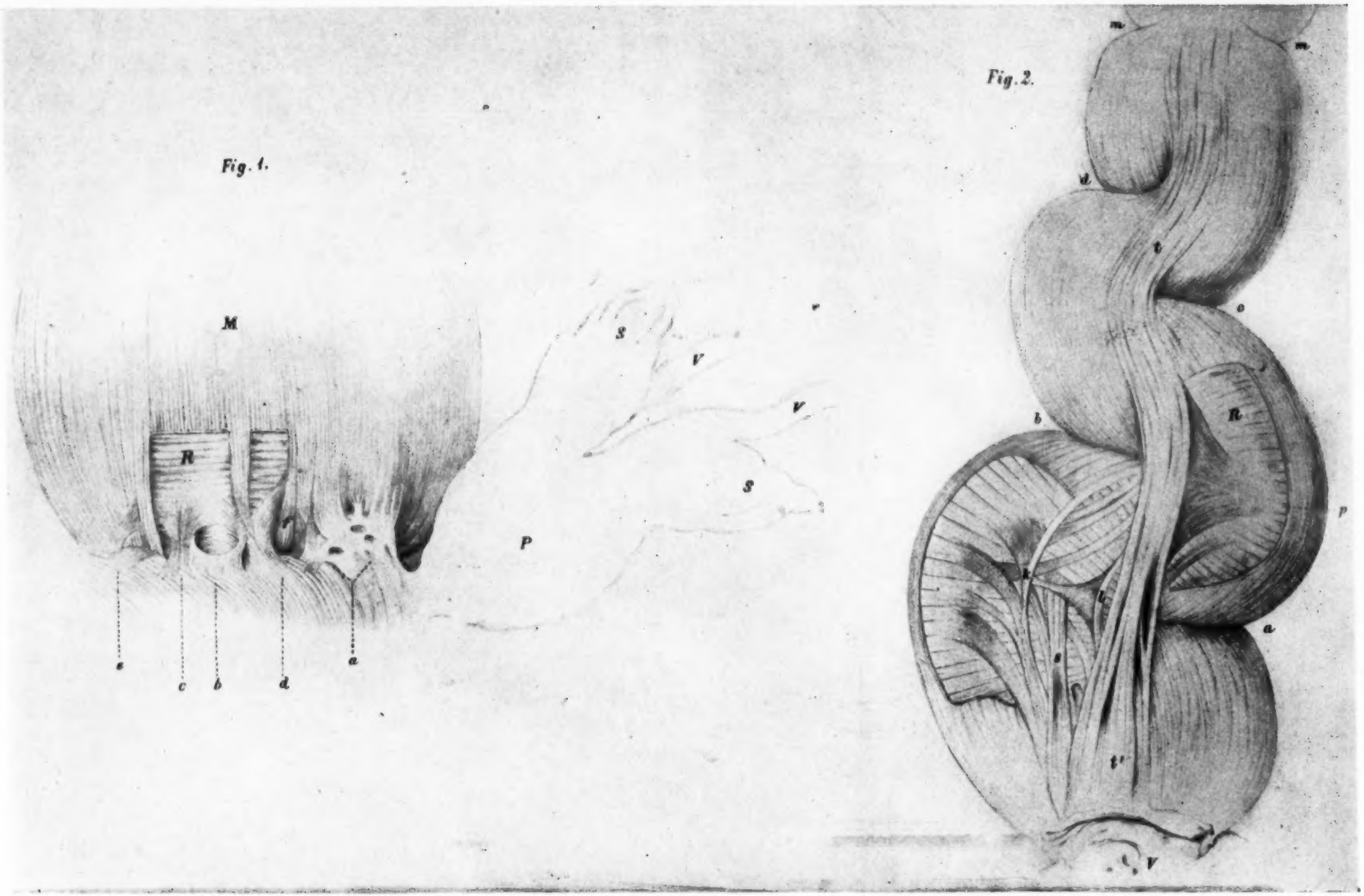

PLATE 6.—Photostat from Lainer. Anatome des Mastdarms. Wiener mediz. Jahrbücher. Jahrg. 1884.

Plate 6

Fig. 1.—Lateral view of the rectum held in a stretched condition by a stream of water, *M*. The longitudinal muscles of the same are removed in two places, to bring into view the underlying circular muscle layer, *R*. The anal levator, *L*, is drawn slightly towards the periphery, so that the proportional structure of the anal levator-rectal connection, may be more easily understood. The prostate, *P*, is separated from the rectum and is presented with its posterior seminal vesicles, *S*, the surface of the intestinal wall turned towards it; *V*, seminal duct. *a*. On the lateral side of the prostate lightly held tendinous tissue. In the same is noticed three circular openings through which run blood vessels. In the upper margin of this tendinously striated broad portion are seen superficial longitudinal fibers of the rectum, in the lower margin of which are inserted superficial levator fibers. In the posterior end of the tendinous striated layer rise two fiber groups, of which one is concealed between the levator bundles, while the other, in an upward direction, breaks through the longitudinal muscle layer of the intestine and continues behind the same in the circular muscle stratum of the internal sphincter. *b*. A tendinous arch seen together with the concavity of the rectal wall, which is fragile, and rises in the connective tissue between the ending fibers of the levator bundles. In the anterior part of the arch are seen also several superficial levator fibers inserted. *c*. Between the bundles of the anal levator, in their upward path over the muscle bundles, are the larger parts of the arches in the round muscle layer of the intestine. Only a few fibers hold their direction upwards, and end in the fragile tendinous cellular tissue between the longitudinal and striated muscle layer of the intestine. From it, in the circular muscle layer of the rectum, striated muscles emerge. Most of them curve forward and run posterior to the lower part of the striated arch, *C*. The latter go through the underlying portion together with the longitudinal muscle parts, and with its fibers, which rise in front of the striated arch, come to the portion between the levator bundles. This is where direct continuation of the same levator muscles extends. *d*. Superficial levator fibers which are separated from the muscle layer of the anal levator. They pull upwards towards the intersection of the longitudinal muscle layer of the rectum, curving in the path of the fibers of the circular muscle layer which proceeds with it. The largest part of the same connects behind the longitudinal muscle group, *f*, with fiber strands which come forward between the levator. These are covered at their origin in the muscle group, *d*. *e*. A thin muscle layer which extends between the bundles of the levators, presses downward to the median levator margin, and follows downwards the longitudinal muscle layer of the rectum to its course.

Fig. 2.—Anterior appearance of the female rectum distended by a stream of water There are four distinct constrictions *a*, *b*, *c* and *d*; the constriction *b* proceeds from the transverse fold. The boundary between the rectum and *s* is marked by a bilateral constriction. The longitudinal muscle layer is withdrawn in a flattened manner, thus bringing the circular muscle layer, *R*, into view. The longitudinal muscle tube occupies an anterior place, a clearly pronounced reenforcement, *t*, *t'* on its anterior side. *V*, the rest of the posterior, with the rectal wall coalescing with the vaginal wall. *p*. A thick triangular layer of fine fiber whose broad basis the longitudinal muscle strands *t*, *t'* touch. It persists in the upper segment of fiber which branch from the longitudinal muscle strand and enter the circular muscle layer. They enter the lower segment of fiber, which proceeds from the circular muscle layer and connects upwards to the longitudinal muscle layer. Beneath this triangular muscle layer can be noticed two narrow delicate groups of fibers, which rise in the connective tissue between the longitudinal and transverse musculature of the rectum, and continue upward to the longitudinal muscle strands, *t*, *t'*. *k*. A bundle of longitudinal muscle fibers of the rectum, to the right and left of which connect the longitudinal muscle strata. On the left side are fastened their longitudinal fiber bundles, which emerge from the transverse muscle layer. Behind the upper segment of the longitudinal muscle bundle can be seen an inverted longitudinal fiber course entering the circular muscle layer. *l*. Likewise a bundle of longitudinal muscle of the intestine. It adheres on the left side, proceeding with a horizontal muscle bundle. Under the longitudinal bundle, *k*, it becomes detached from the circular muscle layer and sends to the longitudinal muscle bundle, *l*, fibers some of which turn upward, others downward. *s*. The longitudinal path of muscle fiber reaching partly the circular muscle layer, and partly the place between the bundle of transverse fibers.

PLATE 7.

Sagittal section through a hardened male pelvis demonstrating the topography of the pelvic musculature, rectum and urethra.

Behind the rectum one sees the section of *f.* fascia visceralis; *rc* muscle rectococcygeus (Treitz); *asm* Art. sacralis media; *pc* muscle pubococcygeus; *ilc* muscle iliococcygeus; *pr* muscle puborectalis; *s* sphincter recti; *spbe*, *spbe'*, *spbe''* muscle sphincter ani externus profundus, superficialis and subcutaneous; *lr* fibroelastic tissue which comes from the longitudinal musculature of the rectum which receives fibers from the diaphragmatic fascia, and go to the surrounding skin of the anus and extend (*spbe'*) to the dorsal surface of the coccyx and builds there the ligament anococcygeum of the author, *spbi* muscle sphincter ani internus. In front of the rectum is seen the section of urethra, prostate, corpus cavernosum urethrae, penis; *vdp* vena dorsalis penis; *ccug* sphincter urethrae membranosae muscle, constrictor canalis urogenitalis; *ltr* ligamentum transversum pelvis (Henle); *lr* fibroelastic fibers with smooth muscle intermixed (end of longitudinal bundle of rectum) which are partly attached in the central tendon and partly end in the skin of the anus, part of the medial fibers build the muscle bulbo cavernosus; *trps* muscle transversus perinei superficialis.

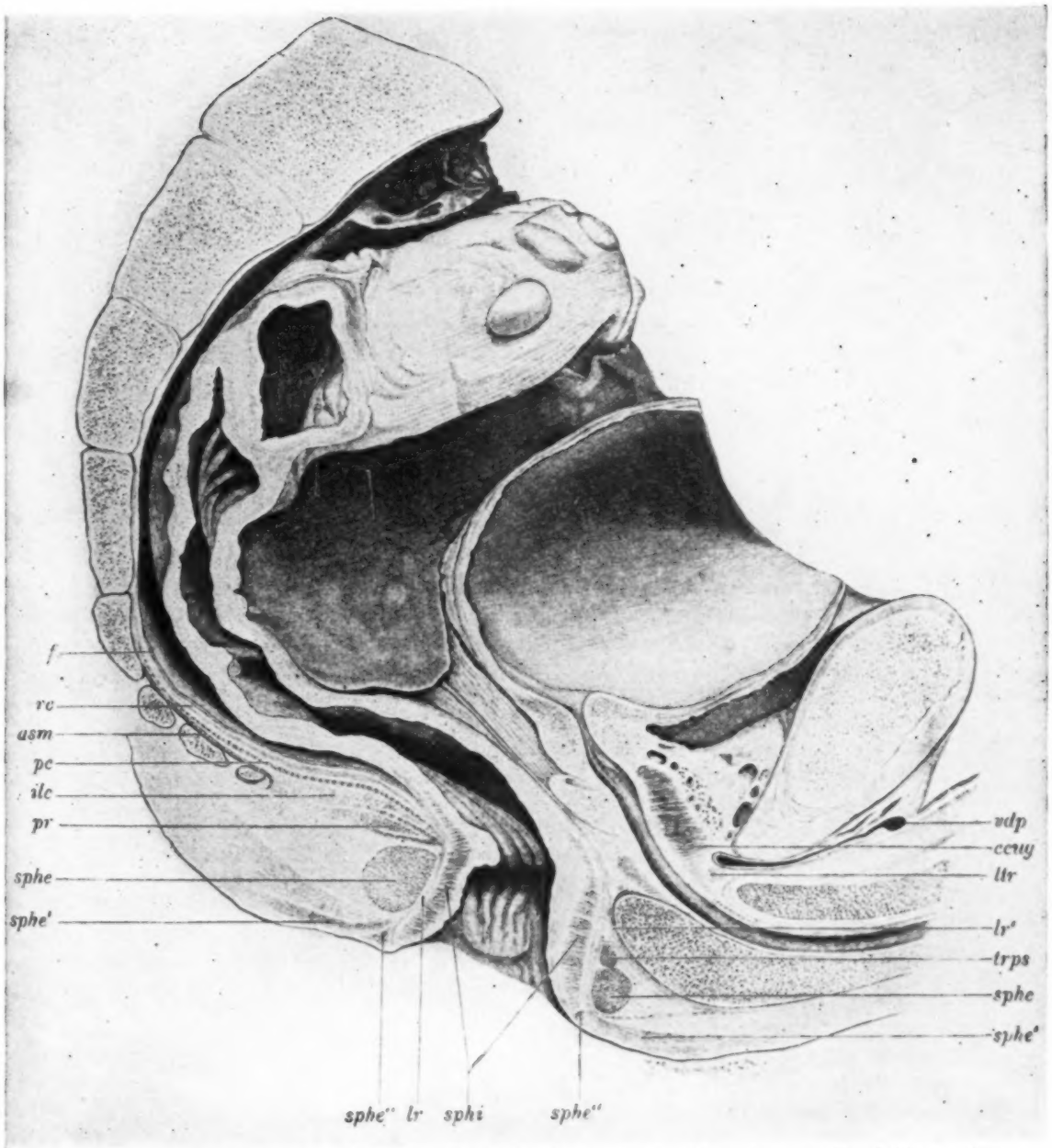

PLATE 7.—Photostat from M. Holl, Handbuch der Anatomie des Menschen von Bardeleben. 1897.

CHAPTER II

DISSECTION OF ANORECTAL MUSCULATURE

The specimen is that of a male Negro, aged sixty-two years, prepared with phenol, glycerine and alcohol, followed by injection of lead and starch.

The cadaver was on its back, with the pelvis flexed on the abdomen, the perineum almost horizontal with the table; the crosspiece, under flexed and abducted thighs, fastened by a strong rope to the frame of the table, maintained the position of the perineum.

The gross dissection is illustrated by photographs and summarized by a schematic drawing.

Fig. 1.—A disk of skin incised circularly 2.5 cm. from the anal orifice was severed from its deep attachments and reflected to its anal border. The circumference of the remaining skin was incised anteriorly to the scrotum, laterally to the tuberosity of the ischium, posteriorly beyond the coccyx, and its flaps reflected; excepting for the anococcygeal area, dull dissection was sufficient.

Vessels and nerves found medially were traced outward, through fat, to their origin from the lateral walls of each space. Posteriorly at each side of the coccyx a nerve was traced for a short depth. The fat was removed.

Coarse markings on the deep surface of the skin show the place of attachment of the severed conjoined longitudinal muscle, 11, their direction is at right angles to the sphincter muscles, 1, 2, 3. The inferior hemorrhoidal division of the pudic structures, Hd1 and 2, traverses the ischiorectal space, IRS, and divides into several branches which penetrate the sphincter musculature at different levels. The deepest and largest branch, Hd2, crosses the deep border of the profundus m., 3, whose superficial border is crossed by the superficial branches, Hd1, which enter the contiguous border of the superficialis m. The subcutaneous m., 1, is partially exposed. The fourth sacral nerve, 4S, pierces the ischiococcygeus m., ISC, at the side of the coccyx, CO, and divides into branches, $4S_1$ and $4S_2$ which enter the coccygeal sphincter at separate levels.

The ischiorectal space, IRS, is a deep hollow on either side of the rectum, filled chiefly with fat through which course the inferior hemorrhoidal artery, vein and nerve, Hd1 and Hd2. The base is the skin between the tuberosity of the ischium and the anus, bounded in front by the posterior border of the triangular ligament, and behind by the great sacrosciatic ligament and the edge of the gluteus maximus. Externally the space is bounded by the tuberosity of the ischium and above the latter by the obturator fascia; internally the space is bounded by the external sphincter and the undersurface of the levator ani. The space narrows above to a line at the fascial attachment of the levator m. to the fascia of the obturator internus. The depth is about 5 cm. The ischiorectal space may more properly be termed the infralevator space.

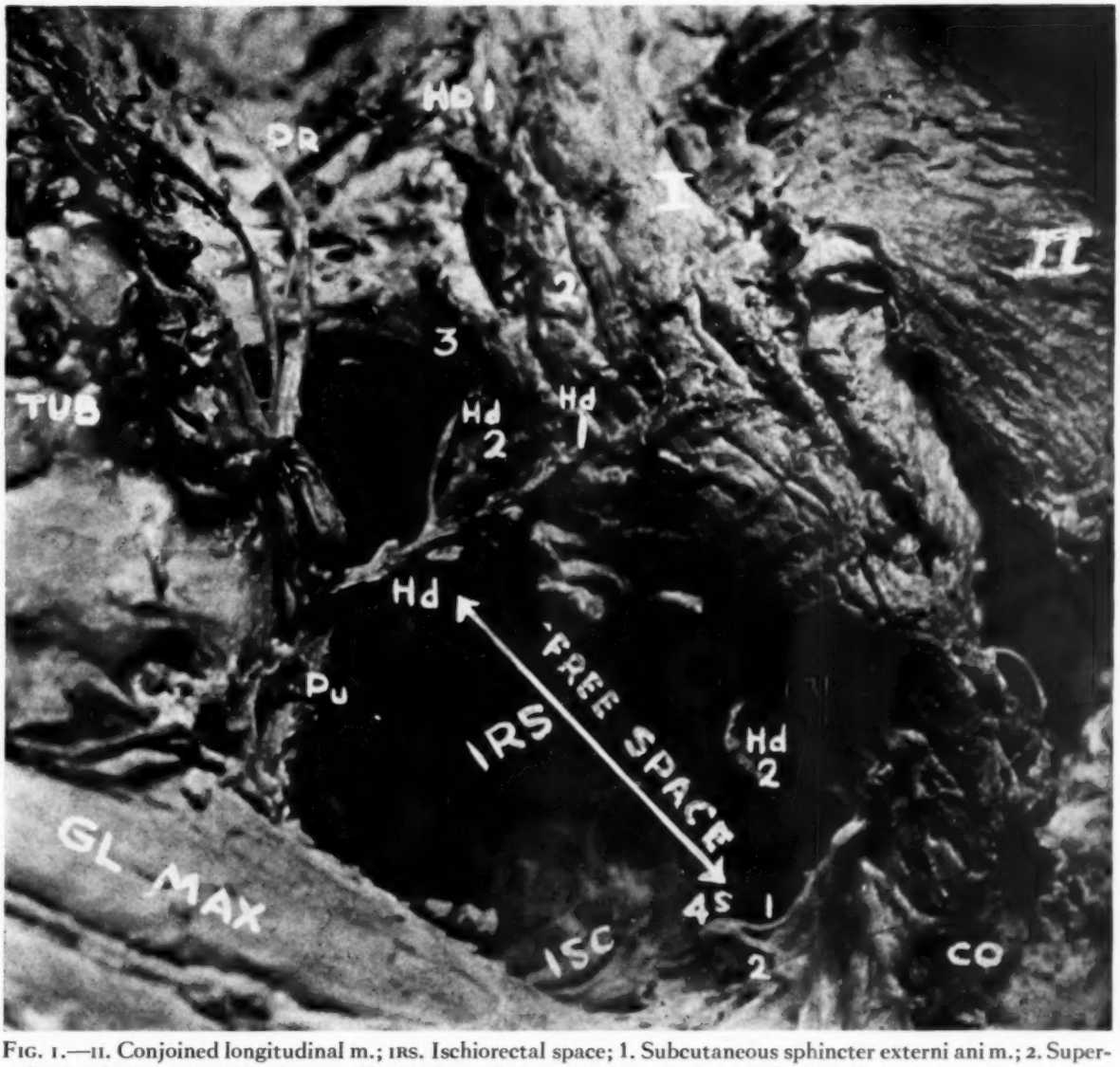

FIG. 1.—II. Conjoined longitudinal m.; IRS. Ischiorectal space; 1. Subcutaneous sphincter externi ani m.; 2. Superficial sphincter externi ani m.; 3. Profundus sphincter externi ani m.; PU. Pudic artery, vein and nerve; Hd. Inferior hemorrhoidal artery, vein and nerve; Hd1. Superficial branch; Hd2. Deep branch; PR. Perineal artery, vein and nerve; TUB. Tuberosity of ischium; GL. MAX. Gluteus maximus muscle; CO. Coccyx; 4S. Fourth sacral nerve; ISC. Ischiococcygeus muscle; $4S_1$. Superficial branch of fourth sacral nerve; $4S_2$. Deep branch of the fourth sacral nerve.

NOTE: The I in the illustration should be 1.

Fig. 2.—The musculature surrounding the anal orifice was cleaned. The subcutaneous sphincter m., 1, was exposed anteriorly by cutting its enclosing sheaths from their attachment to the deep anal lining. The posterior portion of the enclosing sheaths were undisturbed. Toothpicks lying on the inferior border of the subcutaneous m. were inserted on each side between the fibromuscular septa and the skin to which they were attached.

The subcutaneous m. 1, lies in the space between the septa of conjoined longitudinal muscle, 11; these septa are attached to the deep anal skin and are firmer posteriorly. The subcutaneous m., 1, gives off legs, L1, posteriorly which unite with similar extensions, L2, from the superficialis m., 2. On the right the profundus sphincter m., 3, takes an attachment from the ischial tuberosity.

Anteriorly, and deep to the hemorrhoidal structures a fascial shelf, FS, extends from the side wall of the ischiorectal space, IRS, to the rectal musculature subdividing the ischiorectal space in front. The space between the fascial shelf and triangular ligament, IRL, is the anterior recess, AR, which extends forward to the pubic attachment of the levator m.

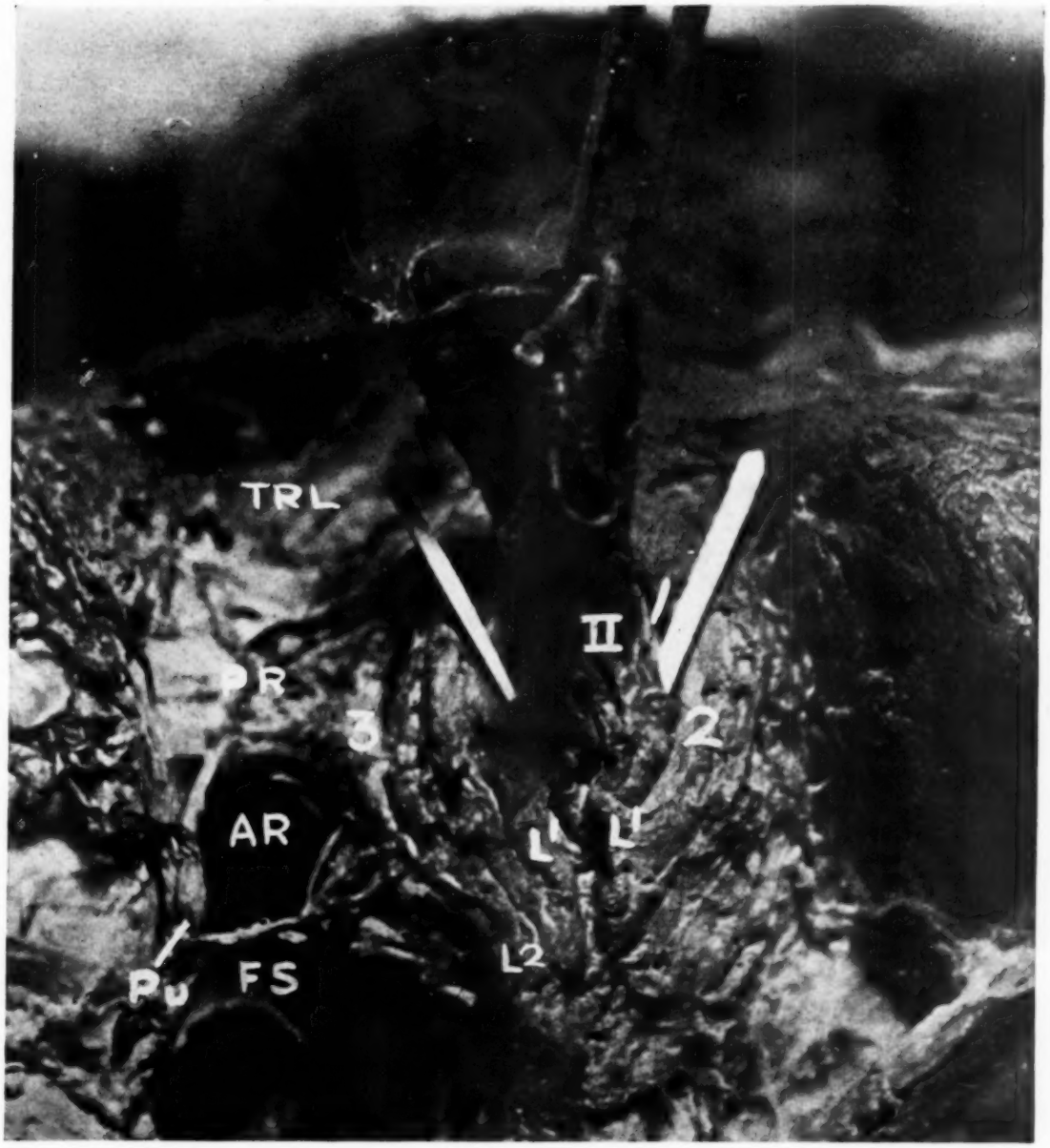

FIG. 2. 1. Subcutaneous sphincter m.; II. Conjoined longitudinal m.; TRL. Triangular ligament; PR. Perineal branches from pudic structure; FS. Fascial shelf; AR. Anterior recess of ischiorectal space; L1. Legs of subcutaneous m.; L2. Legs of superficialis m.; PU. Pudic artery, nerve and vein; 2. Superficialis externus sphincter ani; 3. Profundus externus sphincter ani.

FIG. 3.—The deep and superficial branches of the inferior hemorrhoidal vessels, HD1 and 2, were traced medially and anteriorly to their muscular supply. The muscle between these branches was cleaned anteriorly as it lay under cover of the superficialis m., 2. The anterior attachment of the superficialis m., 2, was raised, laid on the left side and a probe was easily passed under it.

Posteriorly the deep branch of the fourth sacral nerve was traced to its muscle of distribution which was freed at its deep border. The coccygeal musculature was raised, laid on the left side and a forceps was easily passed beneath it. The longitudinal portion of the superficialis m., 2, was stretched and the freshly cleaned muscle was pulled out.

The ischiorectal spaces communicate above at the deep border of the superficialis m., 2, by way of the anterior communicating space, ACS; below, they communicate at the deep border of the coccygeal portion of the sphincter ani musculature by way of the posterior communicating space, PCS.

The deep branch of the inferior hemorrhoidal artery defines the deep border of the sphincter ani m. The superficial branch defines the deep border of the superficialis m. The muscle between these branches is the profundus, 3, or deep division of the external sphincter m. The outer wall of the superficialis m., 2, is free from the profundus m., 3, which has been pushed aside; this outer covering of the superficialis is the outermost layer of the conjoined longitudinal m., 11. The irregular appearance of the superficial anococcygeal area, 2, is due to the severed attachment of the conjoined longitudinal m., 11, to the deep skin.

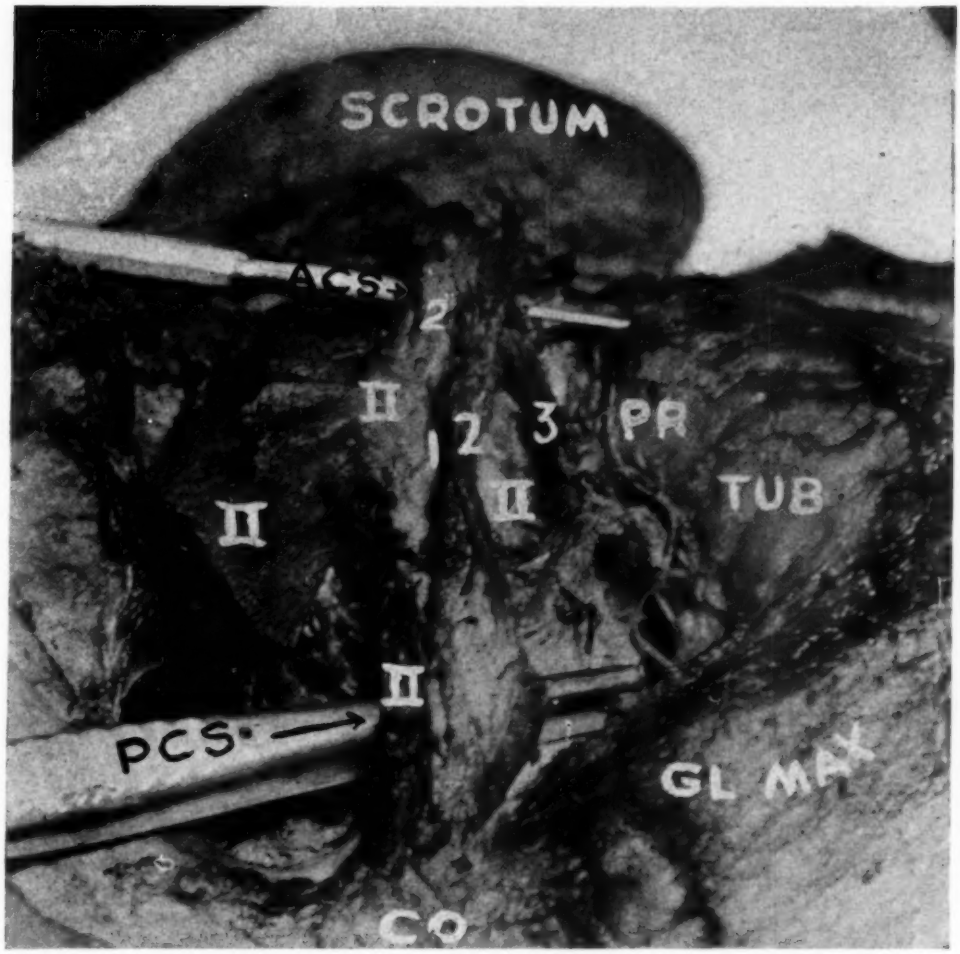

FIG. 3. ACS. Anterior communicating space; PCS. Posterior communicating space; 3. Profundus sphincter m.; 2. Superficialis sphincter m.; II. Conjoined longitudinal m.; 1. Subcutaneous sphincter m.; TUB. Tuberosity of ischium; CO. Coccyx; GL. MAX. Gluteus maximus m.

FIG. 4.—The profundus m., 3, on the right side was pulled out. The superficial longitudinal fibres of the superficialis m., 2, were traced anteriorly to the deep layer of the superficial fascia (Colle's fascia), and posteriorly, to the back of the coccyx, CO; the legs, L2, were everted.

Anteriorly the superficialis sphincter m., 2, is attached to two structures; the scanty superficial fibers cross and join with Colle's fascia, the deep fibers fuse with the musculature of the perineal body at the midposterior border of the triangular ligament. The latter attachment bridges the space occupied by the anterior portion of the profundus m., 3, thus creating the anterior communicating space.

The longitudinal fibers of the superficialis sphincter m., 2, extend posteriorly by two legs, L2, to the back of the coccyx, CO; medially the legs of each side are joined by deeper muscle bundles from the circular fibres that run obliquely and meet on a median line which is attached loosely to the coccyx. The small legs of the subcutaneous m., 1, fuse with the midportion of this trough which is clothed on its deep and outer surface by the conjoined longitudinal m., 11. The space enclosed by the conjoined longitudinal m., 11, of this anococcygeal area and the skin of its attachment is commonly called the posterior triangular space. It is really the coccygeal portion of the superficialis space bounded by the septa of the conjoined longitudinal m., 11, and the skin to which they are attached. The tiers of the conjoined longitudinal m. with its attached skin bound spaces in which are confined the divisions of the sphincteric musculature. Of these spaces only the posterior triangular space is named.

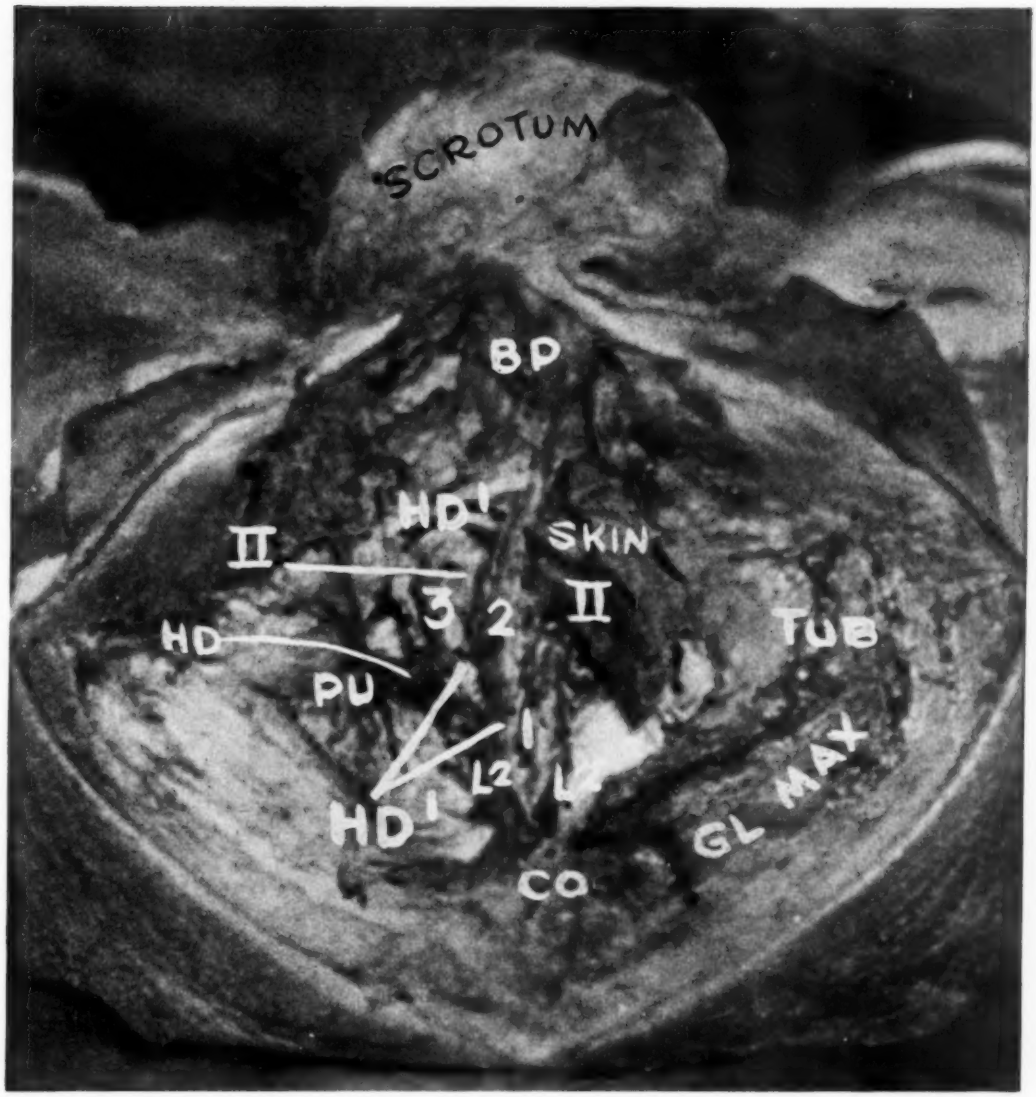

FIG. 4.—II. Conjoined longitudinal m.; 2. Superficialis sphincter m.; L2. Legs of superficialis m.; 3. Profundus sphincter m.; 1. Subcutaneous sphincter m.; HD. Inferior hemorrhoidal vessels; PU. Pudic artery, vein and nerve; CO. Coccyx; BP. Bulb of penis; TUB. Tuberosity of ischium; GL. MAX. Gluteus maximus m.

FIG. 5.—The subcutaneous m., 1, was freed by dividing its tiers of conjoined longitudinal m., 11, close to the anal lining. The superficialis m., 2, and profundus m., 3, were laid back. Anteriorly Colle's fascia, CF, was incised and reflected from its raphé; posteriorly the right leg of the superficialis m., L2, was pushed aside. A U-wire was left under the profundus m., 3, in the posterior communicating space. The superficialis m., 2, was laid on its outer side. The deep branch of the fourth sacral nerve was traced into the leg of profundus m., L3.

The subcutaneous sphincter m., 1, is closely applied to the anal lining. The septa between the subcutaneous m., 1, and the superficialis m., 2, is thick. The superficial fibers of the subcutaneous m., 1, anteriorly unite with the superficial fibers of the superficialis m., 2; posteriorly, their legs, L1 and L2, fuse. The legs of the profundus m., L3, are attached to the back of the coccyx, CO, deep to the superficialis m., 2, from which it is separated by outermost layer of the conjoined longitudinal m., 11. The perineal structures lie deep to Colle's fascia, CF, which separates them from the skin of the perineum.

FIG. 5.—1. Subcutaneous m.; L1. Leg of subcutaneous sphincter m.; 2. Superficialis m.; L2. Leg of superficialis sphincter m.; 3. Profundus m.; L3. Leg of profundus sphincter m.; II. Conjoined longitudinal m.; BP. Bulb of penis; CF. Colle's fascia; TR_{L}. Triangular ligament; GL. MAX. Gluteus maximus; CO. Coccyx.

FIG. 6.—The subcutaneous m., 1, on the left side was freed along its anal border from a septum which was divided from its attachment to the anal lining. White, shiny, circular muscle bundles, 1, appear and were exposed for a few millimeters to a septa attached to the membrane between the muscle and the anal lining; this was divided and a similar procedure followed. Four divisions of this circular, white, shiny muscle bundle enclosed between tiers were identified; the first division, 1, was photographed. The mucous lining was dissected for 1 cm. from its submucous layer. Small veins were identified in all septa. The perianal skin was laid on the right side, the subcutaneous, 1, and superficialis, 2, muscles were spread out.

The white, shiny musculature, 1, is the termination of the internal circular muscle of the intestinal canal. At intervals of every few millimeters concentric bundles of this muscle, 1, are divided and then enclosed by septa which are attached to the anal lining and muscularis mucosa of this region. These concentric white bundles comprise the internal sphincter of the anus, 1.

Anteriorly the major portions of the superficialis m., 2, and subcutaneous m., 1, are circular. The superficial fibers of the superficialis m., 2, blend with Colle's fascia, CF, while the profundus m., 3, lies deep to the anterior attachment of the superficialis m., 2. Laterally the continuous sheet of the septum between the subcutaneous, 1, and the superficialis, 2, muscles is now seen as a thick structure, 11; its attachment posteriorly to the deep surface of the perianal skin is reenforced. Posteriorly the subcutaneous, 1, and superficialis, 2, muscles continue the circle seen anteriorly; from their superficial fibers, legs are prolonged from the profundus, L3, the superficialis, L2, and subcutaneous muscles. The conjoined longitudinal m., 11, of the outer surface of the superficialis m., 2, separate this muscle from the profundus m., 3. The musculature of the posterior superficialis, 2, appearing as a triangle with its apex near the coccyx, CO, separated on each side from the profundus m., 3, by the conjoined longitudinal muscle, 11, occupies the triangular space; its base is the skin to which its enclosing septa are attached.

FIG. 6.—I. Sphincter internus ani; 1. Subcutaneous sphincter m.; L1. Legs; 2. Superficialis sphincter m.; L2. Legs; 3. Profundus sphincter m.; L3. Legs; II. Conjoined longitudinal m.; CF. Colle's fascia; ISC. Ischiococcygeous m.; CO. Coccyx; Hd. Hemorrhoidal artery, vein and nerve; Hd1. Superficial branch; Hd2. Deep branch.

FIG. 7.—On the right side the internal sphincter, I, was exposed. Terminal branches of the inferior hemorrhoidal structures, HD3, were exposed in the tier between the internal sphincter, I, and the subcutaneous m., 1, and traced to the deep surface of the anal skin.

Legs of the superficialis m., L2, were pushed to the left, and a leg of the profundus m., L3, was turned outward. The conjoined longitudinal m., 11, clothing the leg of the superficialis m., L2, separates it from the profundus m., L3.

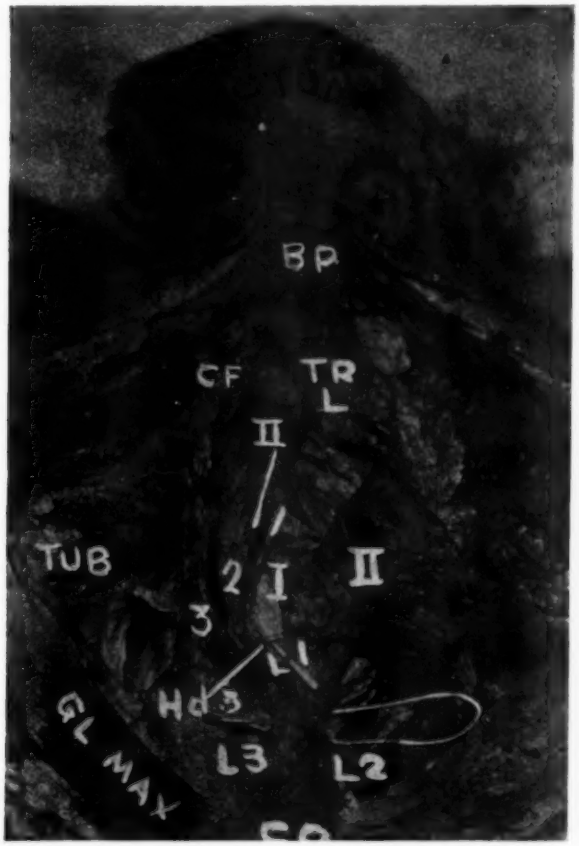

FIG. 7.—I. Internal sphincter ani; Hd3. Terminal division of inferior hemorrhoidal artery, vein and nerve; 1. Subcutaneous sphincter m.; L1. Legs; 2. Superficialis sphincter m.; L2. Legs; 3. Profundus sphincter m.; L3. Legs; II. Conjoined longitudinal m.; TR_L. Triangular ligament; BP. Bulb of penis; CF. Reflected Colle's fascia; CO. Coccyx; TUB. Tuberosity of ischium; GL. MAX. Gluteus maximus m.

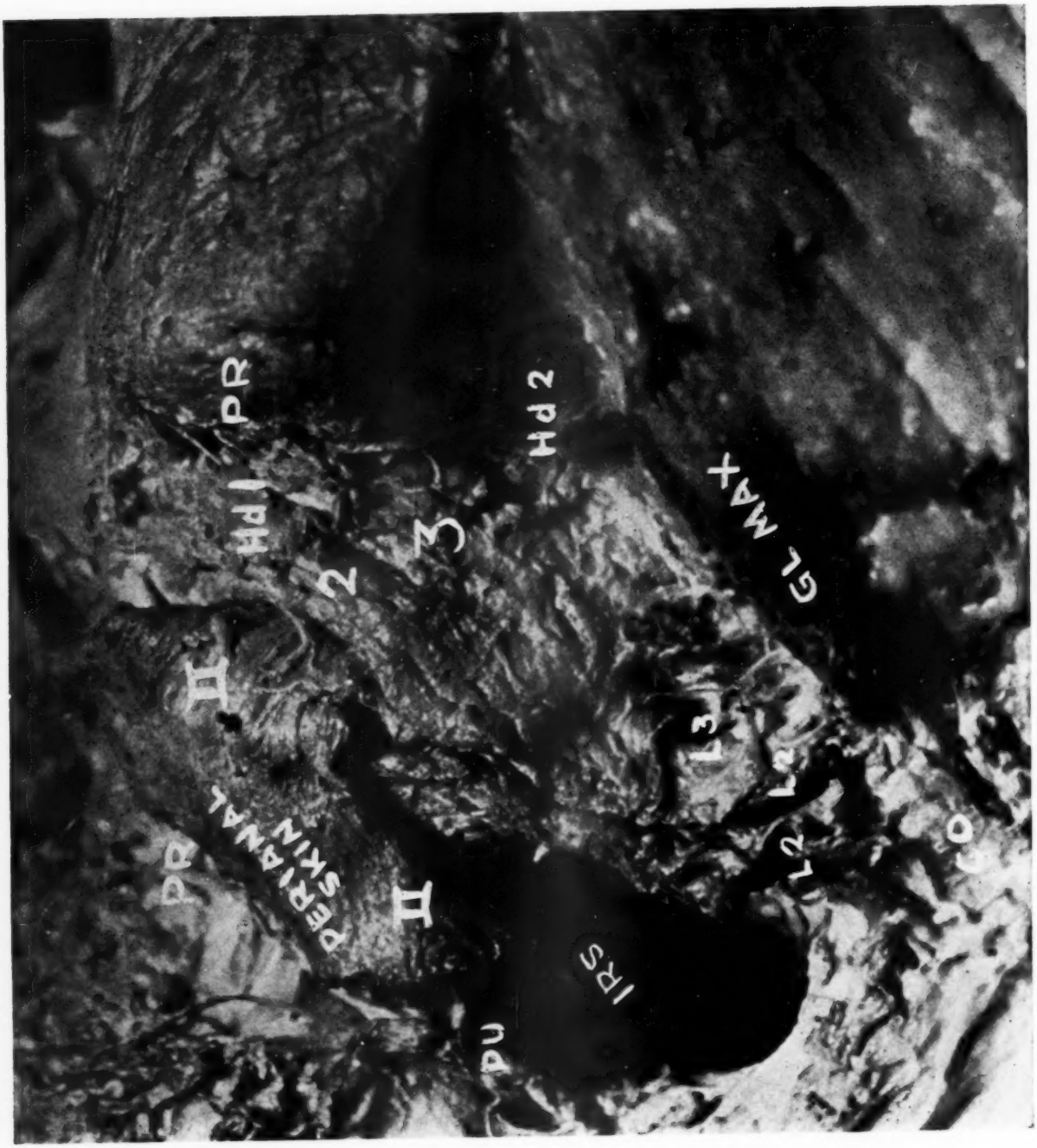

FIG. 8.

FIG. 8.—The sphincter externus ani was cleaned to its attachment on the back of the coccyx, CO. The musculature composing this attachment arises by one-half of each side of the circular portion of the sphincter and proceeds directly on its same side to its attachment which is effected by the two powerful legs of muscle, L2, L3; between the legs of each side is a small opening which leads into the posterior communicating space.

Each side of the posterior extension from each division of the sphincter has a cross sectional surface equal to half of the muscle of its origin. Therefore the combined volume of the two legs of insertion, L2 + 3, on either side, are equivalent in volume to the largest volume of the entire sphincter ani muscle.

2. Superficialis m.; L2. Leg; 3. Profundus m.; CO. Coccyx; HD2. Deep branch of inferior hemorrhoid artery, vein and nerve; HD1. Superficial branch of inferior hemorrhoid artery, vein and nerve; PR. Perineal division of PU. Pudic structures; IRS. Ischiorectal fossa; II. Conjoined longitudal m.; GL. MAX. Gluteus maximus m.
NOTE: The dark shadow on the left leg, L2, is due to an accidental indentation of the musculature.

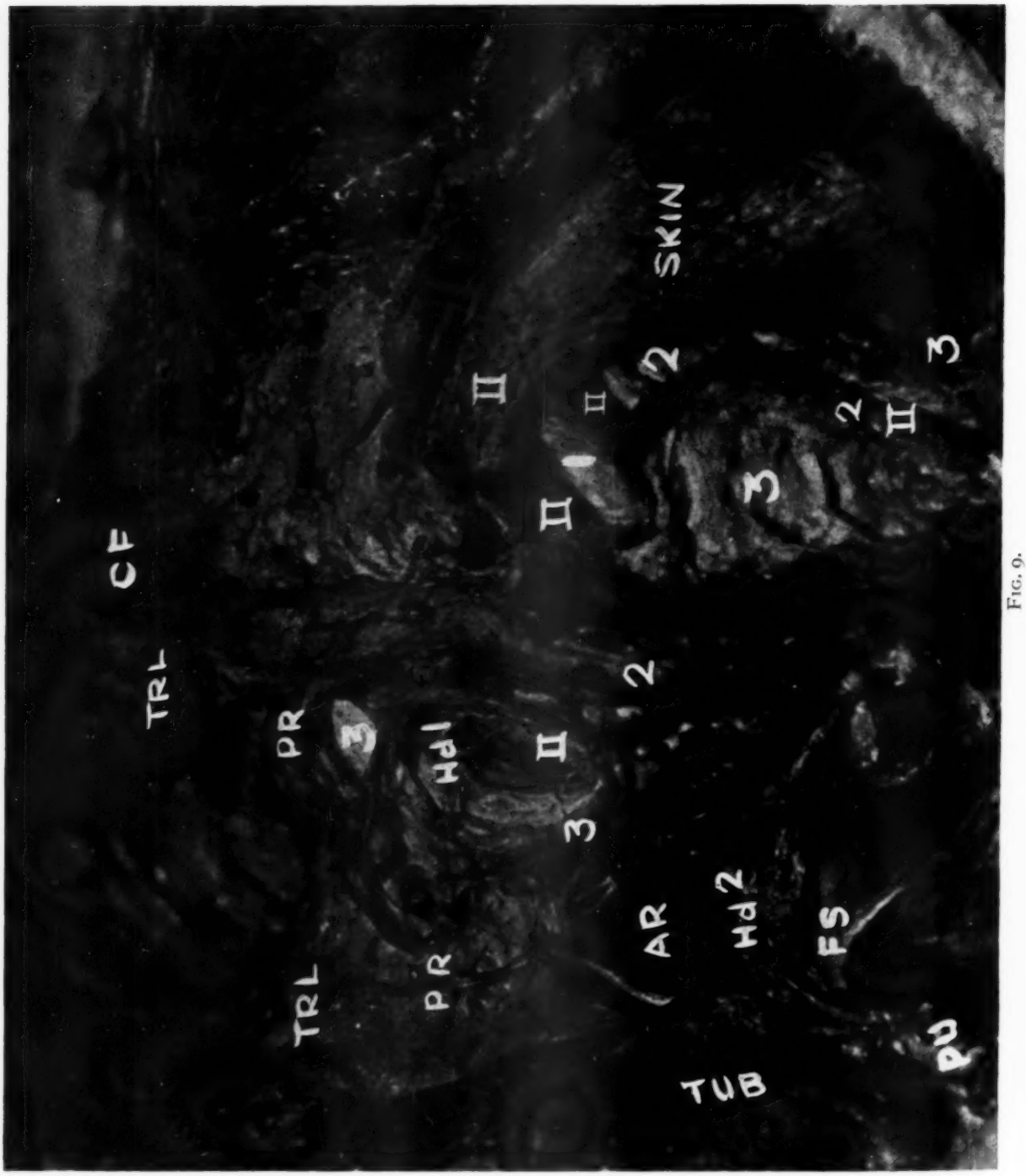

FIG. 9.

[34]

FIG. 9.—Posteriorly the circular fibers of the superficialis m., 2, were cut, exposing circular fibers of the profundus m., 3. The septum between the subcutaneous, 1, and the superficialis, 2, muscles was plainly seen. The profundus m., 3, was found to be separated from the other divisions of the sphincter and was lying in a deeper plane.

1. Subcutaneous m.; 2. Superficialis m.; 3. Profundus m.; 11. Conjoined longitudinal m.; CF. Colle's fascia; TRL. Triangular ligament; PR. Perineal branches of the pudic structures; AR. Anterior recess; FS. Fascial shelf; PU. Pudic structures; HD1. Superficial hemorrhoidal structures artery, vein and nerve; HD2. Deep hemorrhoidal structures artery, nerve and vein.

FIG. 10.—Anteriorly, Colle's fascia, CF, was cut. Deep fibers of superficialis m., 2, were severed from the posterior midborder of the triangular ligament T_{LR}; posteriorly the legs of the superficialis m., 2, were cut; and the freed muscle was laid over on its right side.

The profundus m., 3, looks like the frame of a tennis racket through which the inferior anal musculature has been drawn. The profundus m., 3, is attached by the anterior border of its anterior portion to the mid-posterior triangular ligament, T_{LR}; from this attachment it hangs freely around the circumference of the anal canal. It is attached by its legs, L3, to the back of the coccyx, CO, where it is supplied by the deep branch of the fourth sacral nerve, 4S. The anterior attachment of the deep fibers of the superficialis m., 2, is turned back and discloses the space which it spanned. By its inner circular border the profundus m., 3, surrounds but is not attached to the wall of the anal canal. The profundis is an extrinsic muscle of the anal canal. The deep branches of the inferior hemorrhoidal artery, vein and nerve, HD2, cross the deep border of the profundus m., 3, to pierce the outermost septum of the conjoined longitudinal muscle, 11, to be distributed to the divisions of the external sphincter confined between the septa of the conjoined longitudinal m., 11.

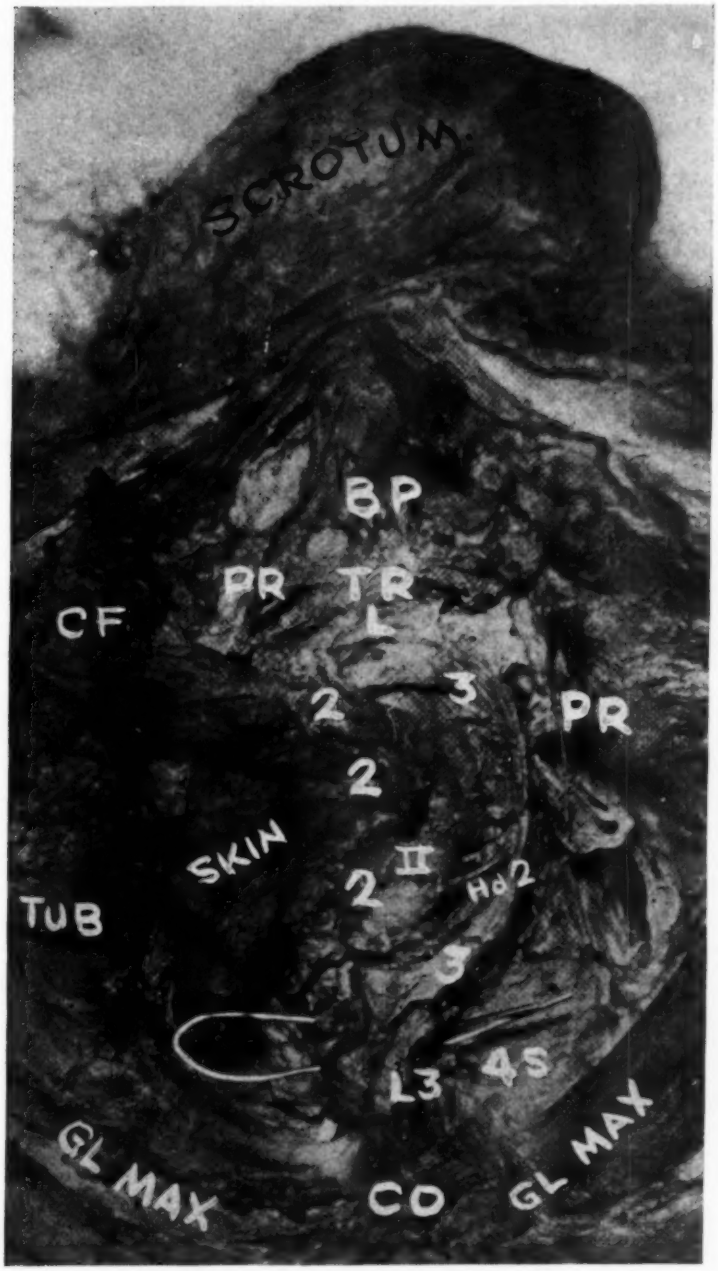

FIG. 10.—3. Profundus m.; L3. Leg; TLR. Triangular ligament; CO. Coccyx; Hd2. Deep branch of inferior hemorrhoidal artery, vein and nerve; II. Conjoined longitudinal m.; 2. Superficialis m.; PR. Perineal branches of the pudic structures; 4S. Fourth sacral nerve; BP. Bulb of penis; TUB. Tuberosity of ischium; CF. Colle's fascia; GL. MAX. Gluteus maximus m.

FIG. 11.—The anal canal was drawn up, the profundus m., 3, was stretched away from the canal, and the posterior attachments were severed from the coccyx, CO, leaving their stumps, L2, L3, on either side, exposed.

The deep branches of the inferior hemorrhoidal structures, HD2, run between the puborectalis, PUR, and the profundus m., 3, to pierce the rectal wall. The puborectalis muscle of each side unites in a sheet of fascia and muscle which attaches itself to the tip of the coccyx, CO. This sheet of fascia is the deep boundary of the posterior communicating space whose superficial boundary is the deep surface of the profundus sphincter legs, L3. The space between the two stumps on the back of the coccyx, which may be termed the superficial coccygeal space, leads into the posterior communicating space, PCS, (Fig. 3). Posteriorly the profundus, 3, puborectalis, PUR, and rectal wall are closely bound by fascia.

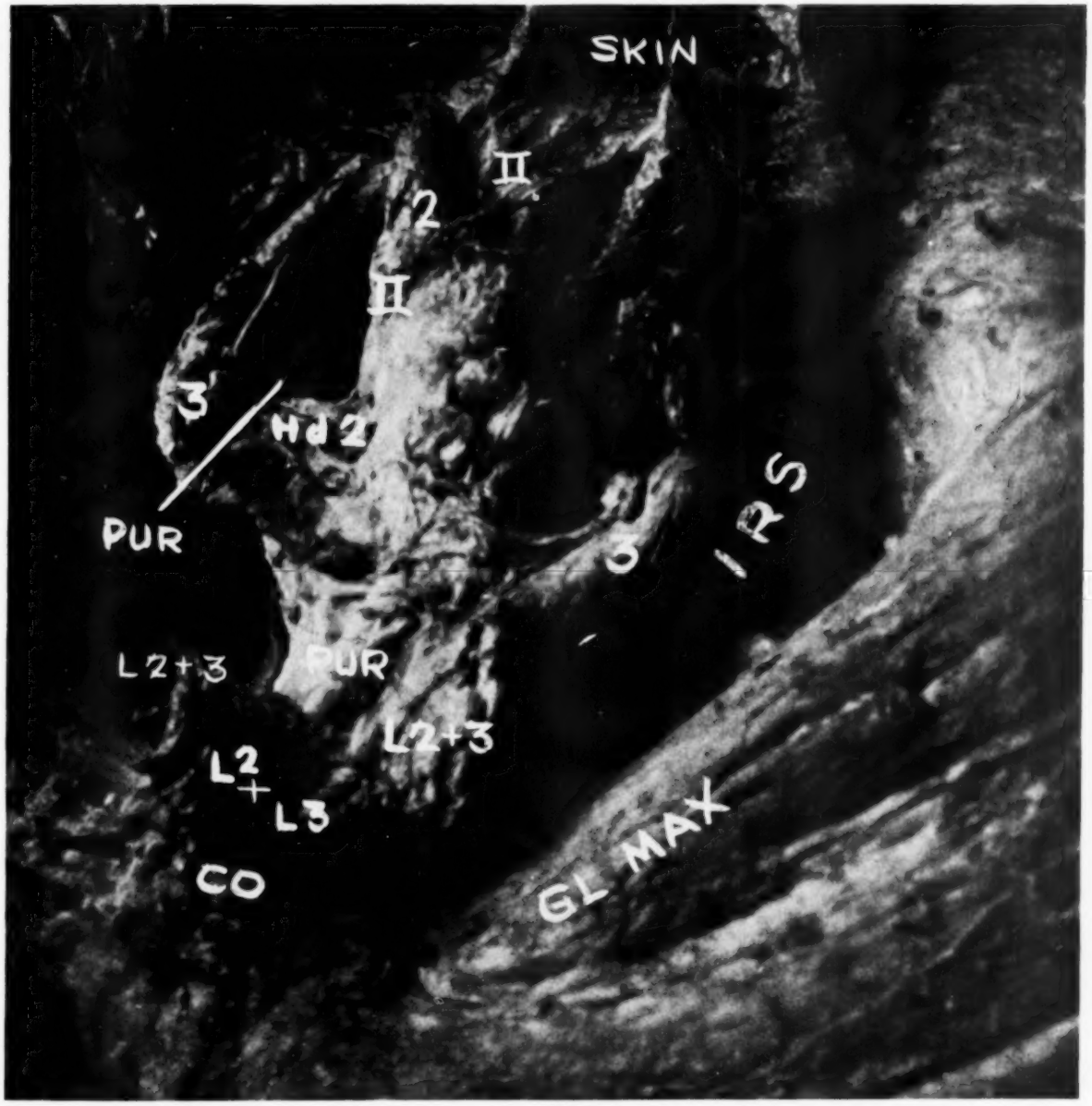

FIG. 11.—PUR. Puborectalis m.; Hd2. Deep branches of inferior hemorrhoidal structures; 3. Profundus m.; IRS. Ischiorectal space; 11. Conjoined longitudinal m.; 2. Superficialis m.; L2 and 3. Legs of superficialis and profundus m.; CO. Coccyx; GL. MAX. Gluteus maximus m.

FIG. 12.—A layer of muscle was peeled down from the deep surface of the perianal skin and laid aside; the skin was held taut.

The coarse markings, 11, of the perianal skin shown in Figure 1, are now proved to be sheets of muscle. The area of skin freed from this muscular layer is semitransparent.

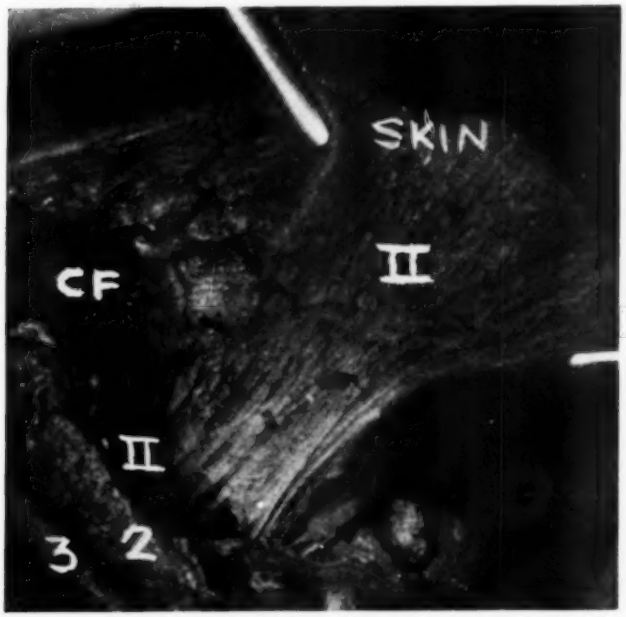

FIG. 12.—11. Conjoined longitudinal m.; 2. Superficialis sphincter m.; 3. Profundus sphincter m.; CF. Colle's fascia.

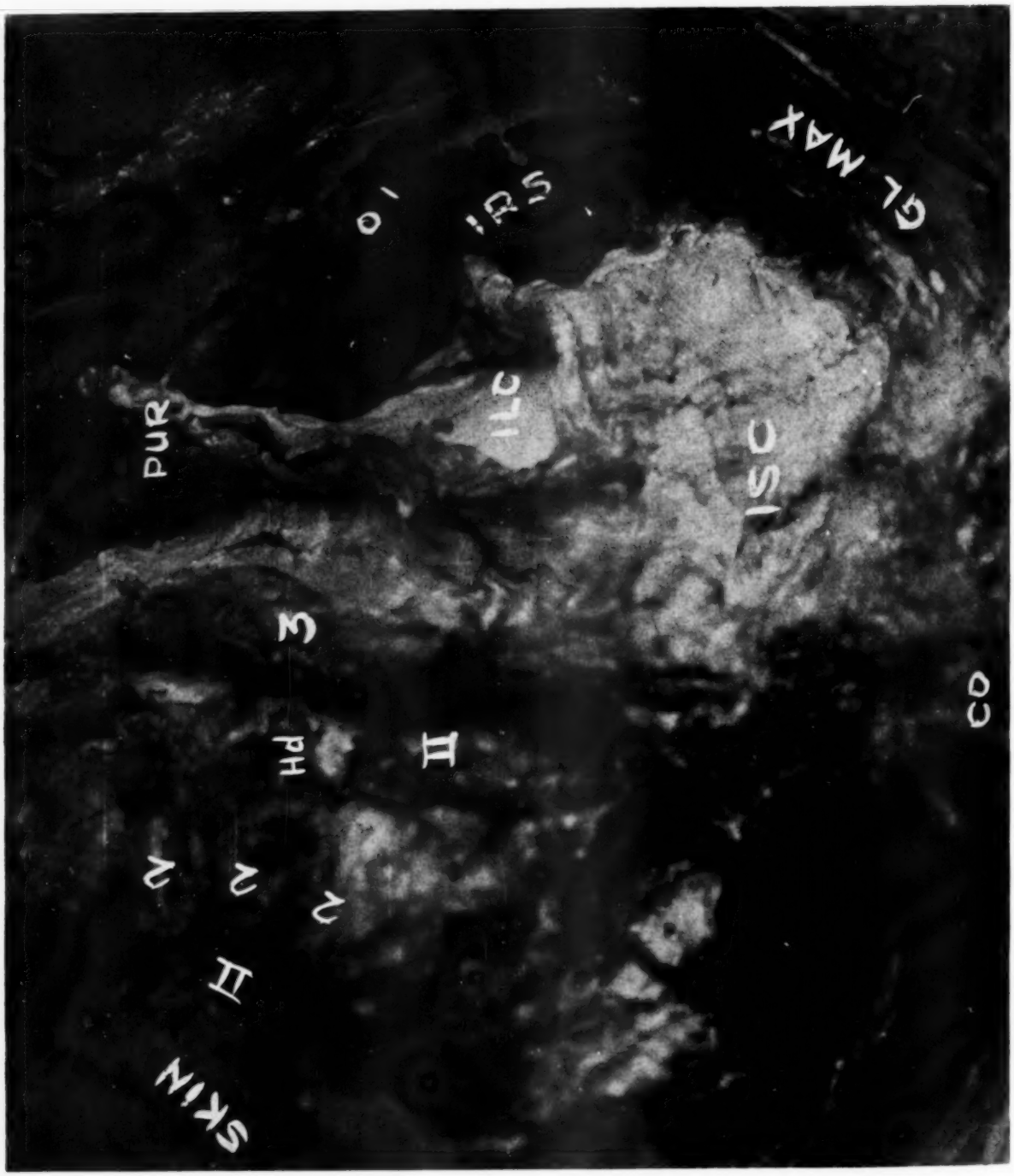

FIG. 13.

FIG. 13.—The fascial shelf, FS, (Fig. 2), was traced medially to the deep border of a muscle which was freed from its fascia. By using the deep hemorrhoidal vessels, Hd, as a guide, this structure was identified as the puborectalis division of the levator ani, PUR.

PUR. Puborectalis; OI. Obturator internus; IRS. Ischiorectal space; ILC. Iliococcygeus m.; ISC. Ischiococcygeus m.; CO. Coccyx; 3. Profundus m.; II. Conjoined longitudinal m.; Hd. Hemorrhoidal structures, artery, vein and nerve; 2. Superficialis m.; GL. MAX. Gluteus maximus m.

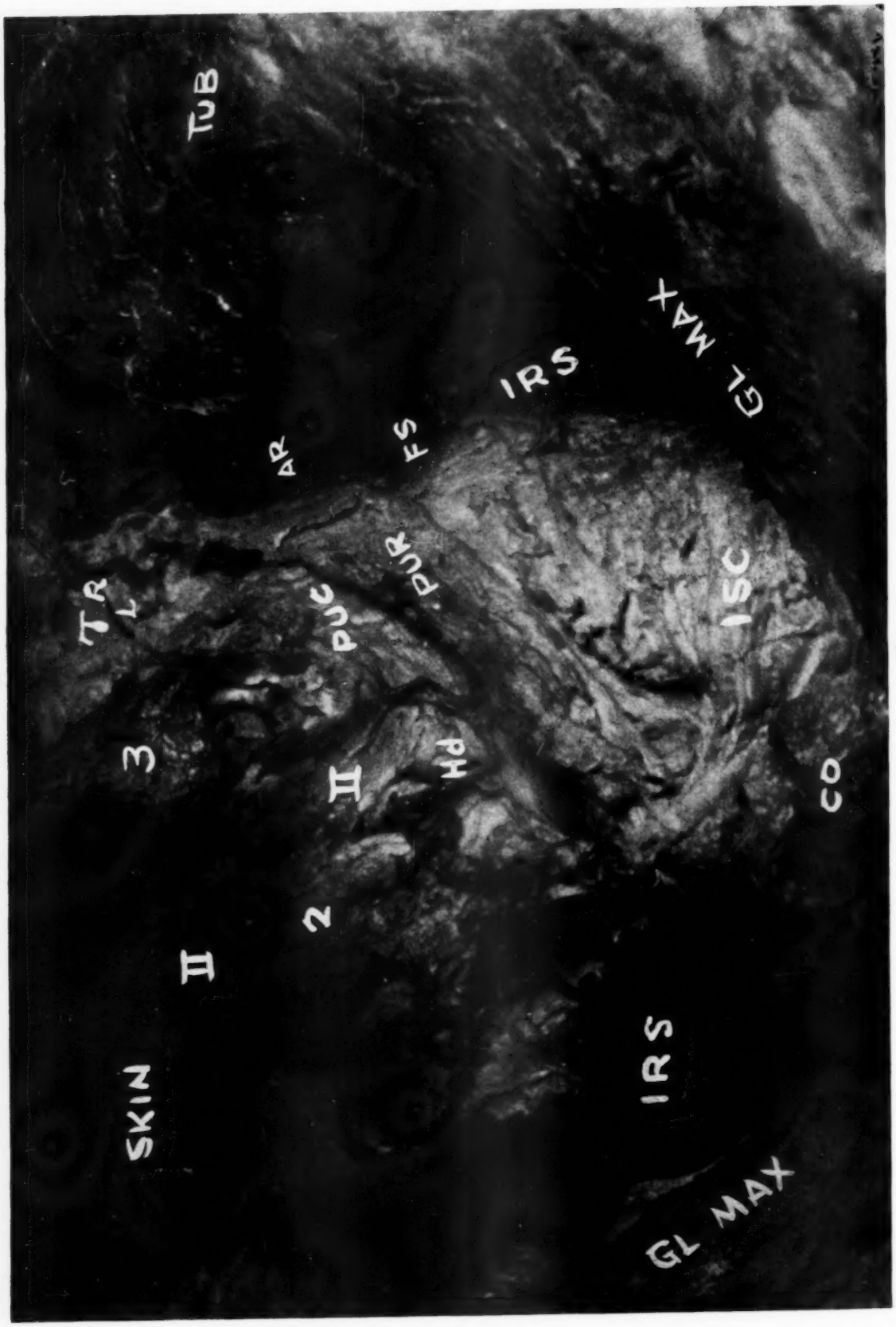

FIG. 14.

FIG. 14.—The puborectalis m., PUR, was traced to the posterior border of the triangular ligament, TLR, where it was attached. The profundus m., 3, was cut anteriorly.

Lying at the side of the rectal wall is a flat muscle, the puborectalis, PUR, division of the levator ani.

PUR. Puborectalis m.; FS. Fascial shelf; IRS. Ischiorectal space; AR. Anterior recess; PUC. Pubococcygeus m.; ISC. Ischiococcygeus m.; CO. Coccyx; HD. Hemorrhoidal structures; 11. Conjoined longitudinal m.; 3. Profundus m.; TLR. Triangular ligament; 2. Superficialis m.; TUB. Tuberosity of ischium; GL. MAX. Gluteus maximus m.

FIG. 15.

FIG. 15.—The puborectalis m., PUR, was raised. A ridge on the rectal wall marks the deep border of the pubococcygeus m., PUC, and the fascial attachment of the deep border of the puborectalis, PUR. A deep groove on the pubococcygeus m., PUC, corresponds to the apposed surface of the puborectalis, PUR. This groove begins midlaterally and gradually becomes deeper as it approaches the posterior midline where it is deepest. The profundus m., 3, also leaves a groove on the anorectal canal which begins anteriorly, 0.5 cm. at either side of the midline, ungrooved area corresponding to the perineal attachment of the fundus; the grooved area becomes more marked laterally and posteriorly.

The distance from the anal orifice to the deep border of the profundus m., 3, is 17 mm., and to the deep border of the puborectalis, PUR, 24 mm.

Measurements of muscles taken from midlateral portion

	Height in Cm.	Width in Cm.
Subcutaneous m	0.6	0.3
Superficialis m	1.0	0.5
Profundus m	1.0	0.4
Puborectalis m	0.5	0.3
at triangular ligament	0.1	1.5
posteriorly	0.5	0.7

PUR. Puborectalis m.; FS. Fascial shelf; PUC. Pubococcygeus m.; ISC. Ischiococcygeus m.; CO. Coccyx; 11. Conjoined longitudinal m.; 3. Profundus m.; 2. Superficialis m.; TUB. Tuberosity of ischium; ILO. Iliococcygeus m.; GL. MAX. Gluteus maximus m.

FIG. 16.—The puborectalis m., PUR, on each side was cleaned; the fibers on the right side were divided from its sheet; the sheet was detached from the tip of the coccyx, CO, and laid to one side to expose the levator plate, PL. The hemorrhoidal vessels, Hd, were turned downward. On the left side the superficialis m., 2, was cut away from its enclosing tiers of the conjoined longitudinal m., 11, leaving its wedge-shaped base.

The subcutaneous m. in the same region was cut away.

Posteriorly a portion of the puborectalis m., PUR, of each side is united in a continuous rope of muscle, closely applied to the rectal wall, thus providing a sling for it. The remainder of the muscle of each side proceeds by legs, L, in a broad fascial sheet which is attached to the tip of the coccyx, CO.

Posteriorly, behind the rectal wall, the pubococcygeus m., PUC, of each side unite and present abruptly a broad flat tendon, the levator plate, PL, by which it is attached to the anterior surface of the sacrococcygeal vertebras.

In the area of the excised subcutaneous and superficial muscles the musculature of the rectal wall appears continuous with the layers on the deep surface of the skin.

The following dissection was not photographed.

The levator plate, PL, was severed from its coccygeal attachment. From its deep surface a broad band of muscle, the rectococcygeus, was traced into the posterior surface of the rectal wall, where it seemed to lose its identity. Dissection at the deep border of the pubococcygeus m., corresponding to the ridge of the puborectalis m., showed fibers of the levator from the lateral pelvic wall running deep to the pubococcygeus m. and disappearing into the wall of the gut.

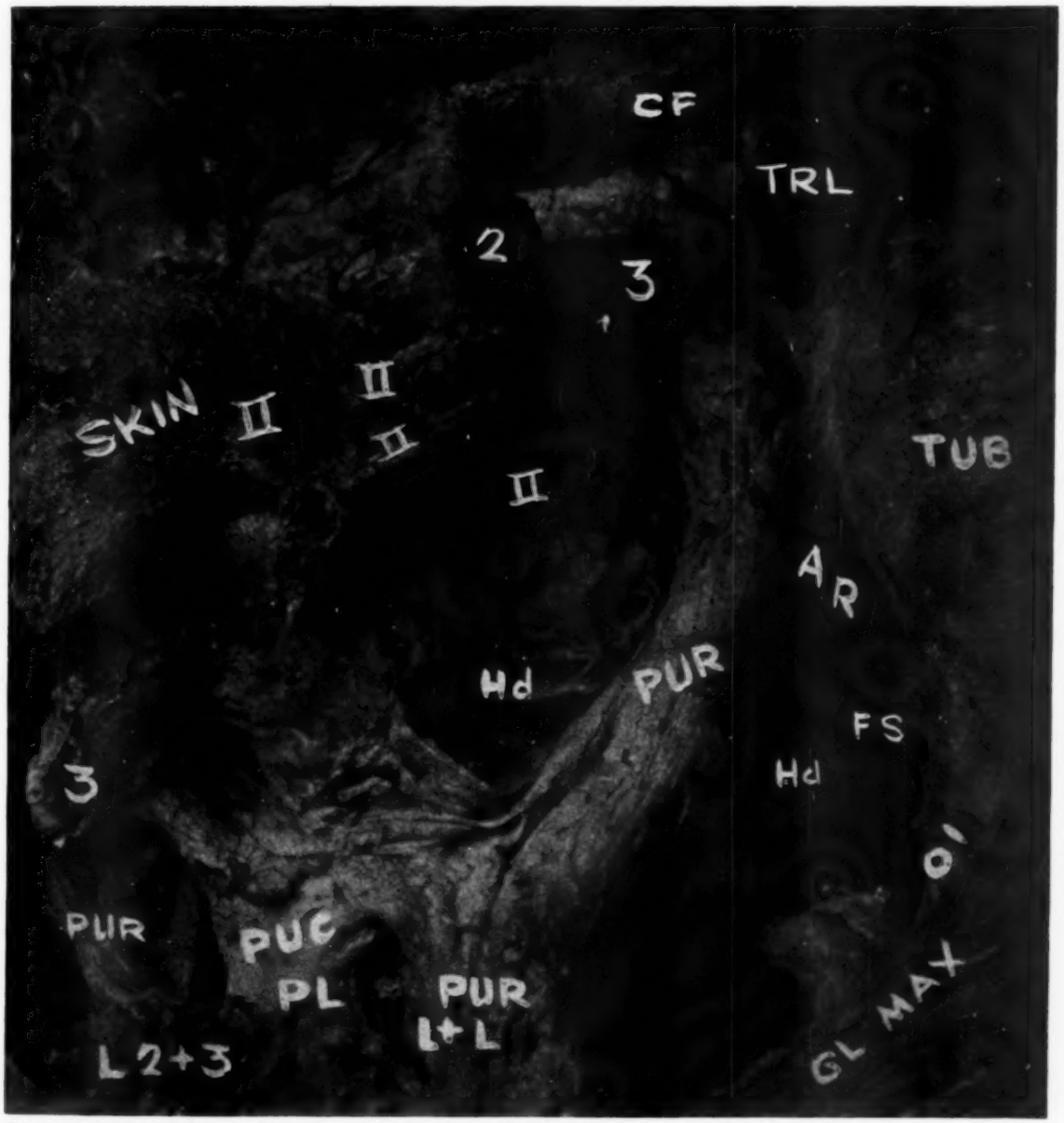

FIG. 16.—PUR. Puborectalis m.; L.-L. attachment by legs and their enclosed fascia (puborectalis sheet); PUC. Pubococcygeus m.; PL. Levator plate; TRL. Triangular ligament; 3. Cut end of profundus m.; 2. Cut end of superficialis m.; II. Conjoined longitudinal m.; L2 and 3. Coccygeal stumps of superficialis and profundis m.; CF. Colle's fascia; TUB. Tuberosity of ischium; AR. Anterior recess; Hd. Hemorrhoidal structures; ES. Fascial shelf; OI. Obturator internus m.; GL. MAX. Gluteus maximus m.

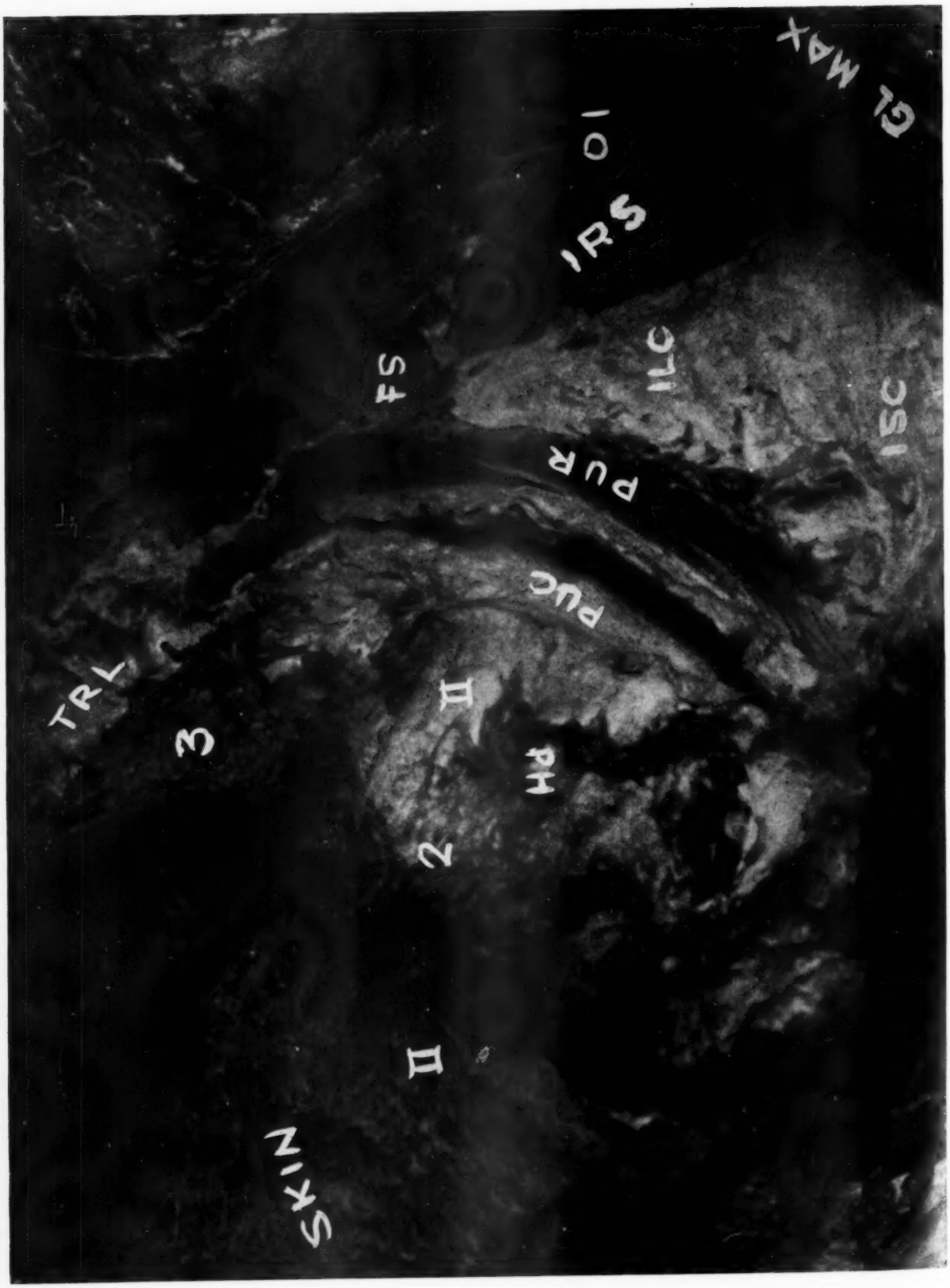

FIG. 17.

FIG. 17.—The puborectalis was spread open along its inner border. It is a twisted muscle resembling a rope; the twist can be followed by tracing the outer border above as it becomes the inner border below.

The puborectalis m., PUR, was seen to be the most superficial of the levator muscles. The puborectalis m. is free from the rectal wall and is in continuous apposition to the lateral and posterior rectal wall, which in this region receives levator musculature. The puborectalis is an extrinsic muscle to the rectal wall. The spiral course of its fibers gives an actual lengthening to the muscle.

PUR. Puborectalis m.; PUC. Pubococcygeus m.; ILC. Iliococcygeus m.; ISC. Ischiococcygeus m.; OI. Obturator internus m.; IRS. Ischiorectal space; FS. Fascial shelf; TRL. Triangular ligament; II. Conjoined longitudinal m.; HD. Inferior hemorrhoidal vessels; 3. Cut end of profundus m.; 2. Superficialis m.; GL. MAX. Gluteus maximus m.

FIG. 18.—An approach to the supralevator space (pararectal) (see Figures 1 and 15).

Inspection of the posterior ischiorectal space at the deep border of the pubococcygeus m., PUC, reveals an area between the hemorrhoidal vessels, HD, and the fourth sacral nerve, which is free from large nerves or blood vessels; this I called the face space. The ischiococcygeus, ISC, and pubococcygeus, PUC, muscles share a layer of connective tissue in which muscle bundles run and give the appearance of continuity to these two muscles. This fascia was incised within the clear space; the ischiococcygeus m., ISC, was displaced posteriorly, and the pubococcygeus m., PUC, was displaced anteriorly. The iliococcygeus m., ILC, or deep fibers of the levator came into view; the direction of its fibers was longitudinal to the axis of the canal. These fibers were separated longitudinally and drawn apart; the rectum was disclosed descending through the supralevator space. An entrance to the supralevator space was effected without sacrifice of any blood vessel, nerve or muscle.

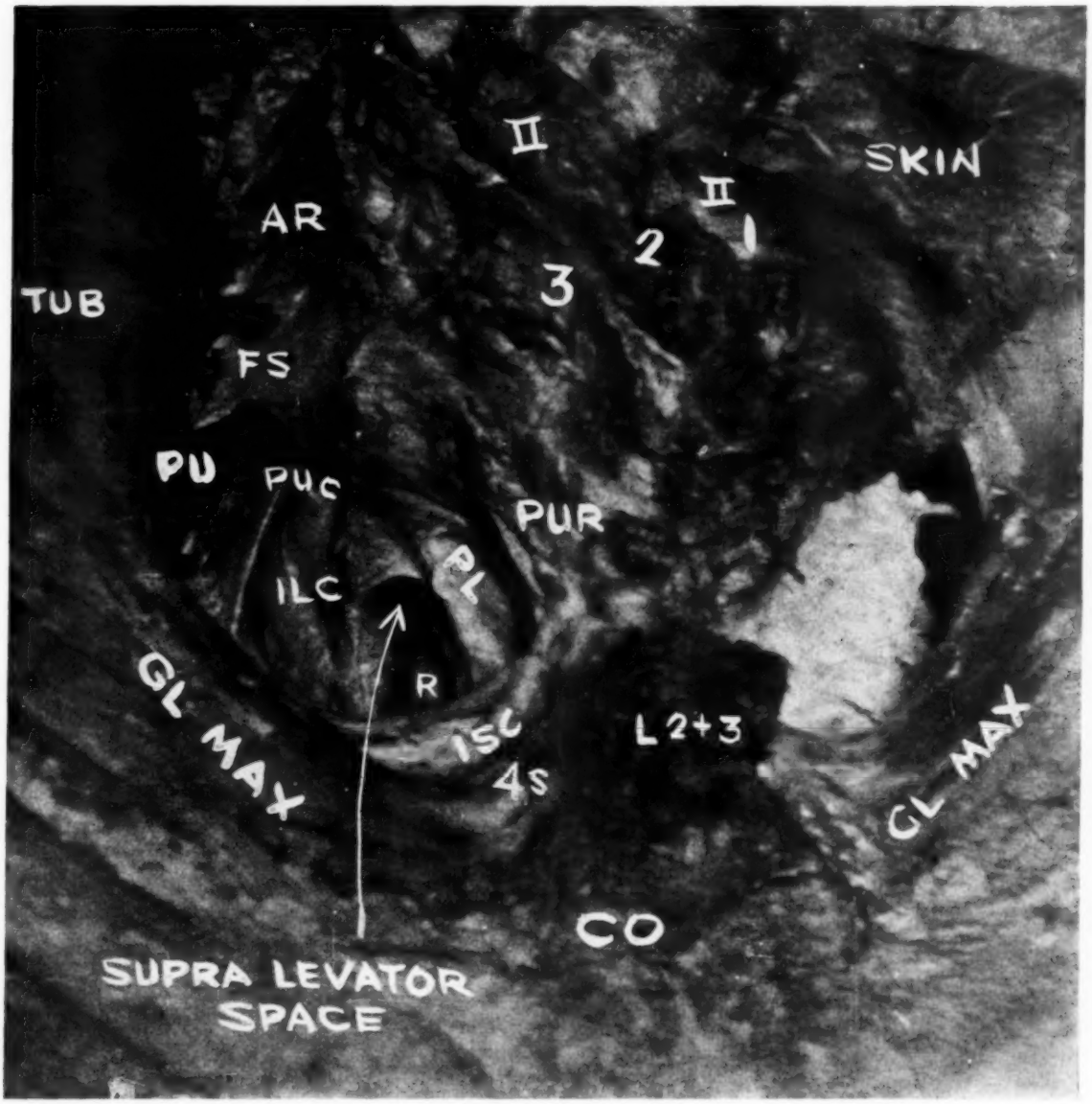

FIG. 18.—R. Rectum; PU. Pudic structures; 4S. Fourth sacral nerve; CO. Coccyx; PUC. Pubococcygeus m.; PL. Levator plate; ILC. Iliococcygeus m.; Arrow in supralevator space; 11. Conjoined longitudinal m.; FS. Fascial shelf; AR. Anterior recess; PUR. Puborectalis m.; 3. Profundus m.; L3. Legs; 2. Superficialis m.; L2. Legs; 1. Subcutaneous m.; ISC. Ischiococcygeus m.; TUB. Tuberosity of ischium; GL. MAX. Gluteus maximum m.

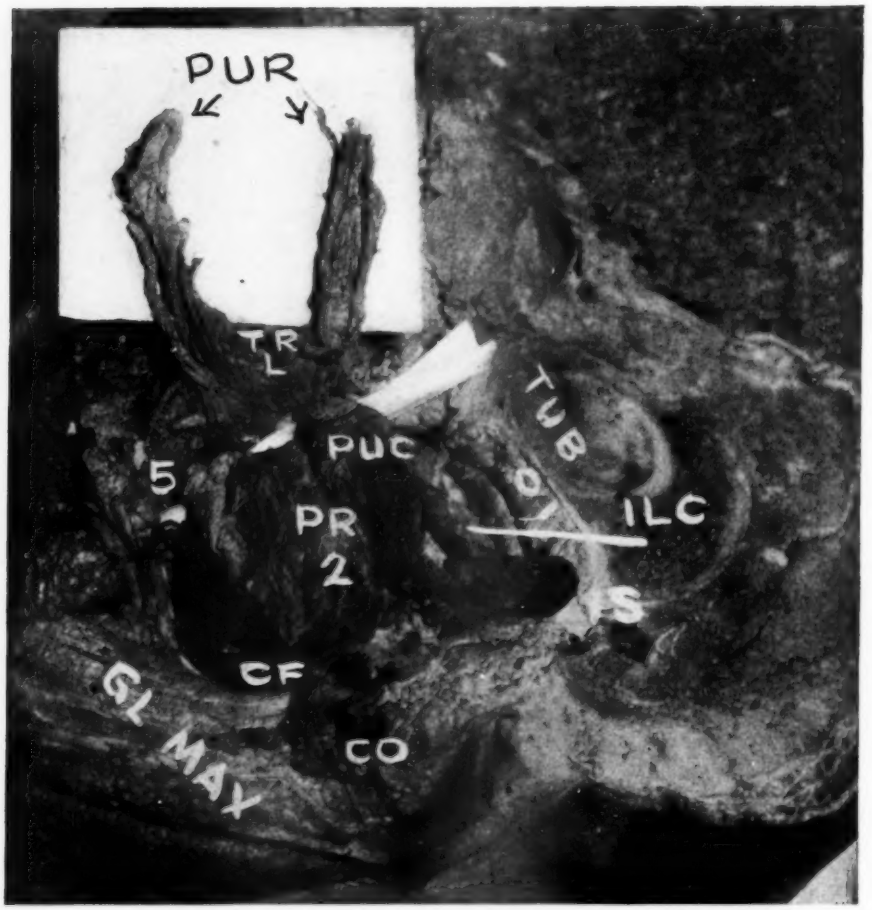

FIG. 19.—PUR. Puborectalis m.; $\frac{TR.}{L}$. Triangular ligament; 5. Superficial transverse perineal m.; PR. Prostate; CF. Colle's fascia; PUC. Pubococcygeus m.; IS. Ischial spine; TUB. Tuberosity of ischium, sawed; OI. Obturator internus muscle cut; ILC. Iliococcygeus m.; 2. Superficialis m.; CO. Coccyx; GL. MAX. Gluteus maximus m.

The puborectalis m., PUR, was divided posteriorly, brought forward, and freed from the subjacent pubococcygeus m., PUC, to its attachment at the posterior border of the triangular ligament, TRL. Here muscle bundles from the puborectalis m., PUR, could be traced to the ramus of the opposite ischium. The pubococcygeus m., PUC, of each side was raised before they became attached to the prostate, and a roll of paper was inserted between the prostate and the pubococcygeus m., PUC, of each side. The left tuberosity of the ischium, TUB, was sawed off.

The anterior wall of the rectum between the pubococcygei, PUC, is composed of smooth longitudinal fibers from the borders of the triangular ligament, TRL, the aponeurosis of the prostate, PR, rectourethralis m. and the anterior longitudinal band of the rectum.

The puborectalis m., PUR, overlaps by its medial borders and separates the pubococcygeus m., PUC, from the triangular ligament, TRL. It arises in common with the pubococcygeus m., PUC, from the back of the pubic body as far as the obturator canal in a flat

thin band which takes attachment to the deep surface and posterior border of the triangular ligament, TRL, as it emerges from the anterior recess, AR. This portion of the muscle is attached by its deep border to the outer wall of the anterior recess, AR, by a fascial shelf, FS, from the fascia covering the obturator internus m., OI. At the mid-posterior border of the triangular ligament it sends fibers to the ischial ramus of the opposite side, helping to form the superficial transverse perineus m. The puborectalis m., PUR, proceeds along the rectal wall and part of the muscle joins with its mate to form a rope of muscle that runs from the pubic bone of one side to the pubic bone of the other. At the back of the rectal wall the remainder of the muscle proceeds as a leg encased with its mate in a sheet of fibrous tissue that is attached to the tip of the coccyx.

The pubococcygeus m., PUC, arises from the back of the pubic body as far as the obturator canal and distributes itself partly to the side of the prostate, PR, partly to the side of the rectum, and terminates with its mate in a strong flat tendinous band which attaches itself to the anterior surface of the last sacral and coccygeal vertebras. The fibers of the pubococcygeus m., PUC, that are inserted into the rectal wall, and therefore intrinsic to it, become incorporated with the smooth longitudinal fibers which they find there, and then unite with them in a fibroelastic muscular structure, which I call the conjoined longitudinal muscle, II. This cylinder, composed of levator and smooth longitudinal fibers, disposes itself into concentric tiers which, proceeding to their destination in the deep surface of the skin and anorectal lining, encounter, divide and then confine between them the effected subdivisions of the sphincteric musculature. (Fig. 20.)

The iliococcygeus m. arises from the thickening in the fascia covering the obturator internus m. and the anterior portion of the spine of the ischium, and terminates partly in the rectal wall (and therefore intrinsic to it) as a component of the conjoined longitudinal muscle and partly in the tendinous attachment to the coccyx of the pubococcygeus m. The iliococcygeus m. is on a deeper plane than the pubococcygeus m.

The ischiococcygeus m. arises from the posterior portion of the ischial spine and sacrospinous ligament, and becomes attached to the side of the sacrococcygeal vertebras. This muscle lies on the same plane as the pubococcygeus. Their common fascia gives them an appearance of continuity.

The muscles of the pelvic muscular diaphragm are the converted tail and caudal muscles of the lower animals, and, as a recent acquisition to man, occasionally reflect their primitive associations by varying their appearance and attachments.

The origin of the conjoined longitudinal muscle is derived from the musculature that enters into its composition: the smooth longitudinal fibers come from, (1) the anterior and posterior longitudinal muscle bands of the rectal wall and from neighboring structures; (2) anteriorly, the aponeurosis of the prostate and the posterior borders of the triangular ligament; (3) posteriorly, the deep surface of the sacrococcygeal vertebras; (4) muscle bundles that arise in the fascia binding the levator muscle with the rectal wall; the striated fibers come from the pubococcygeus and iliococcygeus muscles. The insertion is by concentric tiers into the deep layer of the skin, anal lining and muscularis mucosa of the rectal canal.

The parts[1] that have been described are the differentiated products of the mesothelial tissue[2] which, binding and supporting the component parts of a structure to individualize it, is continuous with its binding and supporting of neighboring structures. This mesothelium (fascia or connective tissue) varies in its density from areolar tissue for loose binding to strong tendon for muscular attachment. A dissection to show layers of fascia will result in artificial structures. Fascia has only been mentioned incidentally in these descriptions.

It may help in understanding the anorectal musculature if it is compared to a loom, constructed around a tube at the lower end of which the fabric is woven. The frame of this apparatus is composed of the soft and hard parts to which the musculature of the anorectal wall is attached. The warp is the longitudinal musculature entering into the composition of the conjoined longitudinal muscle; the woof is the sphincteric musculature. The fabric is the sphincteric musculature within the tiers of the conjoined longitudinal muscle. (Fig. 20.)

From this point of view the musculature of the anorectal canal participating in the formation of the loom comprises its intrinsic muscles; the mechanism that can deform the loom but does not enter into its construction comprises the extrinsic musculature.

[1] Lewis W. H., in Keibel and Mall, Human Embryology, Vol. 1. 1910, pp. 454–459.
[2] Keith, Arthur, Human Embryology and Morphology, 4th edition, p. 412.

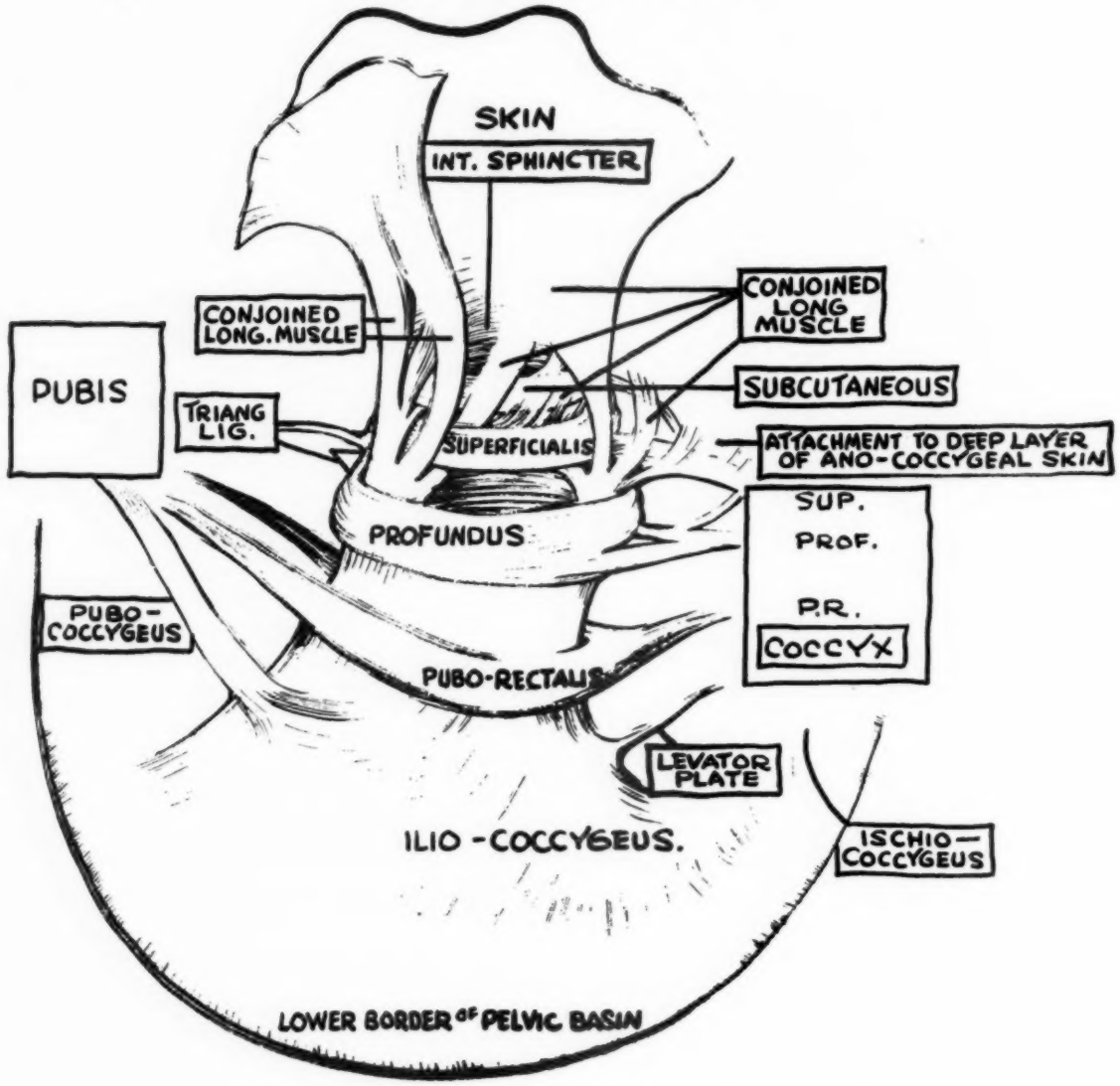

FIG. 20.—Pictorial conception of the anorectal musculature.

I. Intrinsic Muscle
  A. Smooth Fibers
    1. Anterior and posterior longitudinal bands of rectal wall
    2. Accessions
      a. Anteriorly—prostate and triangular ligament
      b. Posteriorly—deep surface of sacrococcygeal vertebras
      c. Bundles arising from fascia binding levator with rectal wall superiorly
    3. Internal sphincter ani
  B. Striated Fibers
    1. Levator ani
      a. Pubococcygeus m.
      b. Iliococcygeus m.
    2. External sphincter ani
      a. Subcutaneous m.
      b. Superficialis m.
II. Extrinsic Muscle
  Striated
  A. Levator ani
    1. Puborectalis m.
    2. Profundus sphincter externus ani
  B. External sphincter ani
    1. Profundus m.

APPRECIATION

I wish to express my grateful appreciation to Prof. H. D. Senior for his kindness and courtesy in extending the use of his anatomical laboratory and library; and to Prof. Jerome M. Lynch and his associate, Dr. G. Johnson Hamilton, for their continuous encouragement. To the artist, Mr. V. Guinness, I am indebted for his drawing and his active interest, advice and work on the photographs; and to the photographers, Messrs. J. R. Fisher, T. Flannagan, H. Reinhart and E. Herman, for their skillful, unselfish and untiring labors. Credit is due to Florence W. Saphir for her accurate translations of the historic Latin, French and German literature, making these available in English for the first time. The preparation and care of the cadaver, as well as the technical assistance of Mr. Ewald Olafson have made possible the prolonged, detailed study of the specimen.

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